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ELEMENTS

OF

HUMAN ANATOMY.

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OF

HUMAN ANATOMY:

GENERAL, DESCRIPTIVE, AND PRACTICAL.

BY

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T. G. RICHARDSON, M. D.,

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"What a piece of work is a man! How noble in reason! how infinite in faculty! in form and moving how express and admirable! in action how like an angel! in apprehension how like a god! the beauty of the world! the paragon of animals."

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TO

NATHAN BOZEMAN, M.D.,
MONTGOMERY, ALABAMA,

WILLIAM FRANCIS EDGAR, M.D.,
U. S. A.,

A. EDGAR SUMMERS, M.D.,
CHARLESTON, VIRGINIA.

GENTLEMEN—

The intimate friendship that existed between us as fellow-students, and the recollections of the many happy hours spent in your society, give me the privilege of uniting your sentiments with mine in dedicating the following pages to our common preceptor,

S. D. GROSS, M.D.,

PROFESSOR OF SURGERY IN LOUISVILLE UNIVERSITY,

to whose wise and judicious instruction and honorable example we owe whatever professional ambition we possess, and for whom we cherish a sincere admiration and most affectionate regard.

T. G. Richardson, M.D.

PREFACE.

In adding another to the numerous list of books on anatomy already before the profession, the author claims no credit beyond that of a common observer, whose experience, in the dissecting-room and amphitheatre, has suggested what he believes to be a slight improvement on the plan pursued by the majority of writers on this branch of physico-medical science. This improvement consists, in the first place, in the union of general, descriptive, and practical anatomy in the same volume; the intention being to render it unnecessary, on the part of the student just entering upon the study, to provide himself with separate books on these different branches; secondly, in the arrangement of the section devoted to practical anatomy so as to secure the greatest possible economy of material; and lastly, in the substitution of English for Latin terms, wherever this appeared to be practicable and judicious.

To the casual critic these may not seem sufficient reasons for obtruding one's self upon the public; but if the experience of teachers and students of medicine accord with that of the author, an elementary book arranged upon some such plan has long been a desideratum; and if the present effort to supply that want prove successful, the author's highest hopes will be realized.

In regard to the matter of the work, it is almost needless to state that the modern writer on anatomy has very little that is new to say, except in the microscopical and chemical department; but the numberless alleged discoveries and theories relating to these divisions of anatomy could not, with propriety or advantage, be intro-

duced into a treatise so elementary as this. In special anatomy, all the principal facts were long ago discovered and published, and even the descriptions themselves have been so carefully expressed by successive writers, that, like the established formulæ of mathematics, they do not often admit of change without prejudice to their clearness and precision.

Louisville University,
Medical Department, October, 1853.

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INTRODUCTION.

Anatomy, in its most comprehensive signification, is the science of organization. Its object is to investigate the material structure of the living creation. There is, therefore, an anatomy of vegetables as well as of animals. The former claims the student's attention, because it both furnishes instructive analogies to animal anatomy and has important practical relations to the mechanic arts.

When anatomy investigates the whole series of animals, and compares the same organs as found in different species and in man, it is called *zoological* or *comparative anatomy.*

Special anatomy is confined to a single species; such is *human anatomy*, the special subject of this treatise. If it considers the organs in their healthy state, it is called *physiological anatomy;* if it describes their diseased condition, it is *pathological anatomy.*

Physiological anatomy may be either *descriptive*, having reference only to the outward characters and mutual relations of the different organs of the body, or it may be *general* (*histology*), and then examines the interior of the organs, and determines their minute texture and composition.

Practical anatomy, or the art of dissection, may be pursued with reference to any of these divisions, or it may have particular regard to surgery. For the latter purpose, the body is mapped off, as it were, into regions, and the several organs found in these regions

considered only in relation to each other. This is called *surgical* or *topographical anatomy.*

The present treatise is intended to be a brief outline of both general and descriptive anatomy, arranged to suit practical dissection as usually taught in this country.

PART I.

GENERAL ANATOMY.

GENERAL ANATOMY.

The simplest general idea of the anatomy of the human body is, that it consists of a collection of various solid, semifluid, fluid, and gaseous substances, held in intimate relation by physical and vital forces, all mutually dependent upon one another, and formed into separate parts or organs, which are arranged in groups for the performance of the great functions of the animal economy. To ascertain the situation, relations, and outward characters of these organs, and their general disposition in the entire body, was, until recently, the object and limit of anatomical study. Before the time of Bichat, no successful effort had been made towards a correct analysis of the body into certain distinct "textures," or "tissues," which are recognized by the unaided senses, and distributed throughout the different parts and organs. This illustrious Frenchman indicated, and followed as far as his means of study and his too short life permitted, this new direction of scientific anatomy. He instituted, in fact, that study of general anatomy, which, at the present day, by means of chemistry and the microscope, is making rapid progress towards the perfection already reached by descriptive anatomy. Bichat and his immediate followers, however, admitted as distinct tissues only the solid parts of the body, which in reference to their distribution he arranged into classes, or "systems," such as the "muscular system," "nervous system," &c. But modern anatomists have most clearly demonstrated that many of the fluids may justly claim a similar designation.

The number of the solid tissues has been variously estimated from seven to twenty. The following table, however, in which only fifteen are enumerated, will be found to answer all ordinary purposes. The old, and most easily remembered classification, into

"general" and "partial" tissues, *i. e.* tissues that are found in every part of the body, and those that exist only in certain localities, is here adopted:—

GENERAL TISSUES	1. Areolar or cellular tissue. 2. Vascular tissue, comprising bloodvessels, lymphatics, and lacteals. 3. Nervous tissue.
PARTIAL TISSUES	4. Epithelial tissue. 5. Pigmentary tissue. 6. Adipose tissue. 7. Muscular tissue. 8. Fibrous tissue. 9. Yellow-elastic tissue. 10. Cartilaginous tissue, including fibro-cartilage. 11. Osseous tissue. 12. Cutaneous tissue. 13. Mucous membrane. 14. Serous membrane. 15. Glandular tissue.

These fifteen tissues constitute the entire organism of the body, with the exception of the spleen, crystalline lens, thyroid body, enamel of the teeth, and one or two other organs, which are probably distinct, but, on account of their very limited distribution, are not usually included in the list of individual tissues. The beginner must not, however, for a moment, suppose that these several tissues are ultimate elementary structures. Some of them, indeed, as the vascular, are composed of *several* tissues, and deserve to be called "organs" rather than tissues; they are all susceptible of being resolved into more minute parts or elements. This ultimate analysis of the tissues, by means of the microscope, into their true "anatomical elements," constitutes the great advance made in the study of the organization of the body within the last five or ten years, and establishes a subdivision of general anatomy almost entirely unknown to Bichat.

The anatomical or constituent elements (called also "microscopic elements," because they can be seen only with the microscope) are few and simple, and must be carefully distinguished from the tissues which they form, and the fluids in which they are suspended. They are:—

1. Minute particles, termed "granules," or "molecules." These are found suspended in greater or less quantities in all the fluids of the body; but they differ in their chemical nature, and in the changes

to which they are subject, according as they exist in the different fluids.

2. "Globules," or "cells," which have usually a spherical outline, and consist of an exceedingly delicate membrane, called the "cell-wall," inclosing a fluid or semifluid substance, and, in most cases, a little body, termed a "nucleus." They exist freely suspended in the different fluids; as, for instance, in the blood, chyle, lymph, and also as large collections, compressed so closely as to form solid tissues.

3. Solid matters, in the form of fibres, tubes, membranes, and homogeneous masses, which, either by themselves, or in conjunction with cells, enter largely into the formation of most of the tissues.

The fluids, aside from the fact that they constitute the largest proportion of the whole body,* are, as already mentioned, quite as important to the general anatomist as the so-called tissues; and the same may also be said of the gases (oxygen, nitrogen, carbonic acid, &c.) found dissolved in some of these fluids; but in the few following pages devoted principally to the solid tissues, only the blood, chyle, and lymph will be noticed.

Physical Properties of the Tissues.—The general physical properties, such as consistence, color, weight, and elasticity, belong, of course, to the animal tissues. During life, these properties are more or less modified by the great, governing, vital forces, and the facts ascertained concerning them by experiments upon dead structures, cannot, therefore, be implicitly relied upon. In fact, many of the properties exhibited after death are wholly incompatible with life, as, for instance, the coagulation of the blood; while, on the other hand, a still greater number are directly concerned in maintaining this condition. Of these several properties a few may be briefly noticed.

Consistence.—The consistence of the animal tissues varies from the stony hardness of the enamel of the teeth to the semifluid con-

* The relative proportion between the fluid and solid parts of the body, although by no means constant, varying greatly in different individuals, and in the same individual under different circumstances, is, nevertheless, usually stated at 4 or 5 parts of the former to 1 of the latter. These figures, however, can be only approximately true, since they are observed by weighing a dead body before and after it has been subject to a thorough desiccation in an oven; an experiment in which not only the fluids are dried off, but some of the solid matters decomposed and dissipated.

dition of fat. Each tissue, however, has a special or natural consistence; which, except in a very few instances, is almost entirely dependent upon the water that it contains. The presence of water, whose amount is nearly the same in all tissues of a similar nature, is absolutely necessary to their existence as tissues; for, deprived of it, they diminish in size, lose their natural color, become hard and pulverable, and often cannot be distinguished from one another.

Imbibition.—The tissues, being for the most part of a somewhat loose texture, are capable of taking up fluids both before and after death, the amount depending entirely upon the looseness of the structure. This property must not, however, be confounded with that of absorption, which is a vital process.

Coagulation.—Many of the fluids that enter into the composition of the tissues, as well as a number of others, coagulate or solidify when placed under favorable circumstances. Thus the brain, when first removed from the body, is soft and easily lacerated, but, immersed for a time in hot water, alcohol, a solution of chloride of zinc, or of corrosive sublimate, it becomes quite firm and resisting, owing to the coagulation of its albuminous element. The fibrine of the blood, chyle, and lymph, by exposure to the air only, suffers spontaneous coagulation.

Elasticity.—All the tissues possess the property, during life at least, of resuming to a certain extent their natural shape and size, after having been stretched or compressed. This is well seen in the retraction of the skin, arteries, and yellow-elastic tissue, and in the return of the child's head to its natural shape, when it has been compressed in passing through the pelvis of the mother. This is a very different property from muscular contractility; which, as will be hereafter shown, is a vital endowment.

*Diosmosis.**—This important property, possessed alike by organic and inorganic matter, was first pointed out by M. Dutrochet, in the

* The substitution of a new term for the two that have been in use ever since the discovery of the property which they designate, needs no apology. It has been generally acknowledged that the words *exosmosis* (εξ, out of, and ωσμος, impulsion), and *endosmosis* (ενδον, within, and ωσμος), the former denoting the weaker and the latter the stronger current, were unfortunately chosen, since, as explained in the text, the weaker current may be passing *into*, and the stronger *out of*, a cavity. The term *diosmosis* (δια, through, and ωσμος) may apply to either or to both.

early part of the present century.* It consists in the permeability of tissues to fluids and gases; or, more explicitly, in the imbibition and interchange of fluids and gases through thin membranous structures; and, although thus simple in its nature, the manner and circumstances of its manifestation, are almost as various as the phenomena of life itself.

The elucidation of this process belongs rather to the physiologist than to the anatomist, but a few of its laws may be stated here.

1. Diosmosis may exhibit itself as the result of pressure alone. Separate two portions of water by an animal membrane (a piece of bladder or intestine, for instance), so that there shall be greater pressure upon one side, and in the course of a few hours a perfect equipoise will be established by the transfer, or diosmosis of a sufficient amount of the fluid through the intervening membrane.

2. Diosmosis will occur when two different fluids, having an affinity for each other, are separated, as in the former case, and allowed to remain some time in this situation. The transudation results solely from the affinity which the fluids have for each other, and for the membrane, and this sometimes occurs even in opposition to pressure. Thus, if a strong solution of common salt is closely secured in a bladder, and immersed in pure water, in a short time the inclosed fluid will be found considerably increased, and the surrounding water diminished in quantity. Moreover, the latter will now have a decidedly saline taste, showing that some part of the solution escaped from the bladder, although a larger quantity of water passed into it. It will thus be seen that two currents of unequal force are established through the separating medium; and, if sufficient time is allowed for the experiment, they will continue to flow until the two fluids have acquired a uniform density, and if, when this has been accomplished, there is unequal pressure upon the membrane, a single current will continue to flow, as in the former case. If the relations of the two fluids are reversed, the water put into the bladder and the saline solution around it, the currents will be reversed also, the stronger directed *from* and the weaker *into* the bladder.

3. If a membrane separates a fluid from a substance that is solid, but soluble in it, as, for instance, dry salt and water, or gum and

* Although the credit of the first analysis of this property is due to the illustrious Frenchman, physiologists are also greatly indebted to Prof. J. K. Mitchell, of Philadelphia, for many useful facts.

water, the fluid will permeate the membrane to combine with the salt or gum, even when opposed to gravity. When, however, a portion is dissolved, a feeble reverse eurrent is established, as in the former ease.

As has been already intimated, it is absolutely neeessary in all these cases that the separated substanees, whether fluid or gaseous, should have an affinity for each other. If oil and water, or any other dissimilar immiscible fluids are used, no interehange will oeeur. It is also equally neeessary that one at least of the two fluids or gases (for the same law governs both) should have an affinity for the membrane; no matter how porous the septum may be, provided it has no large holes, unless this eondition exists, there will be no transudation; and, on the other hand, all other things being equal, in proportion to the strength of this affinity will be the strength of the diosmotie eurrents.

Chemical Properties of the Tissues.—By means of ehemical analysis the human body may be resolved into its ultimate elements,* whieh are the same as the elements of the inorganie kingdom. The number of these simple or elementary substances known to exist in the body, is seventeen. They are oxygen, hydrogen, earbon, nitrogen, phosphorus, sulphur, chlorine, fluorine, potassium, sodium, caleium, magnesium, iron, silieon, manganese, aluminum, and eopper. Of these, the four or five first mentioned are far more abundant than all the others; those last named oeeur only in the smallest quantities.

The combinations of these ehemical elements are very different from those found in vegetable struetures, and differ still more widely from those eomposing inorganic bodies. Throughout the whole inorganie world, simple substanees or elements unite in twos, forming *binary compounds*, which maintain their individual existenee until exposed to deeomposing influenees stronger than their eombining affinity. In the organic kingdom, however, the preserving influenee of a vital foree permits a more complex union. In plants, the most eommon eombination is the *ternary*. Vegetable tissues are almost entirely eomposed of earbon, oxygen, and hydrogen; and, when deprived of life, and exposed to the destructive ageneies of air, water, and ealorie, they resolve themselves into

* The student must not fail to note the distinction between ultimate *chemical* and ultimate *anatomical* elements.

binary compounds. In animal structures, which possess a much higher grade of vitality than vegetables, we find the most complex combinations; in these, nitrogen is added, forming, with the three just mentioned, *quaternary compounds*, which are much more liable to decomposition than vegetable structures. In the chemical analysis of animal substances, however, we do not come immediately upon these ultimate elements, but upon compound bodies, some of which belong to the mineral, and some to the animal kingdom. In the analysis of bones, we first separate them into their organic or animal, and inorganic or earthy constituents; the latter consisting of phosphate and carbonate of lime, chloride of sodium, &c.; and the former, of fibrin, albumen, fat, and other ternary and quaternary compounds. These animal and mineral compounds are called *immediate*, or *proximate*, constituents; and both, when submitted to farther analysis, yield the chemical elements already mentioned.

The proximate *inorganic* substances of the body are numerous, and widely diffused, and subserve most important purposes in the performance of many of the functions. Water, for example, is a component part of every tissue and organ, and of every secreted substance, whether solid or fluid; and, although of a passive nature, is absolutely essential to the vital forces. Although these inorganic constituents are numerous and largely distributed, none of them, excepting, probably, the saline and iron elements of the blood, take any active part in the great vital processes; this is the office of the organic bodies.

The proximate *organic* substances, notwithstanding their chemical elements are few, are as numerous and as plentifully distributed as the inorganic. They are all composed of carbon, oxygen, hydrogen, and, with one or two exceptions, nitrogen. The *ternary*, or non-nitrogenized, are fat, sugar of milk, and one or two others. The *quaternary* (in which nitrogen is present) are albumen, fibrin, casein, gelatin, chondrin, alcoholic extractive, aqueous extractive, salivin, kreotin, pepsin, globulin, mucus, honey matter, pigment, hematin, pyin, urea, uric acid, and certain principles of the bile. These several substances are the immediate and active agents, by which the vital functions are carried on. They differ, however, very greatly in their importance to the economy, in the complexity of their composition, and in the circumstances under which they are produced. Thus, albumen, fibrin, casein, gelatin, and perhaps one or two others, form a class whose office is decidedly higher than that of the others. By their superior vital endowment

(and not in consequence of their chemical composition) they have the power of eliminating from certain fluids substances precisely similar to themselves in composition, and possessed of the same vital properties. They are, indeed, highly vitalized *organs*, whose true qualitative and quantitative chemical analysis has probably never yet been made. It is true that in nearly all the recent works on chemistry, tables of the composition of each are given; but in the hands of the chemist these substances are dead, their characteristic properties are lost, and who can say, with any degree of certainty, that in this condition their elements are the same, in quality and quantity, as in the living state?

The other organic constituents perform rather a secondary part in the animal economy, with the exception, perhaps, of the fatty matters of the brain, whose uses are not yet certainly ascertained.

VITAL PROPERTIES.—By the term vital property, is to be understood that peculiar principle existing in all organic substances, by which they are enabled to resist the decomposing influences that constantly surround them, and to perform certain functions which, in their physical capacity alone, would be, as far as we know, entirely impossible. In the animal creation, this property manifests itself in three principal modes, and has hence been divided into as many kinds, otherwise called powers or forces. These are: 1, the motor force or power (contractility), producing motion; 2, the sensitive power (sensibility), producing sensation; 3, the nutritive power, producing nutrition.

1. *Motion.*—Contractility, or the power to contract (in the vital sense of the word) upon the contact of certain stimuli is the special property of muscular fibre. In order to excite this property, which, when not disturbed, remains in a latent or dormant state, the stimulant may be applied directly to the tissue, or to one of its nerves. In either case, the muscle, if it is one of these organs upon which the experiment is made, will be seen to diminish in length, and enlarge or swell out transversely; and, if its minute fibres are examined, they will be found changed from a perfectly straight to a zigzag direction. The stimuli may be a mechanical or chemical agent, or some influence generated in the nervous centres. Some of the other tissues also are said to possess vital contractility; but upon this point physiologists are not agreed. It is true that some of them shrink upon the application of certain excitants, but it cannot be

positively asserted that this shrinking is the effect of the same force that generates ordinary muscular contraction.

2. *Sensation.*—It is the office of the nerves not only to conduct influences *from* the brain and spinal cord to the muscles in the exercise of the will, but also to convey *to* these centres impressions made upon particular parts of the body, which parts are supplied with sentient nervous filaments, and are, therefore, said to possess sensibility. Now, although it is by the brain that these impressions are properly received and recognized, yet there is doubtless some change in the nerves of the part upon which they are first made; and the sensibility of any part is proportioned to the number of its sentient nerves. Thus, the hair, nails, epidermis, and some other structures are, in all probability, entirely destitute of sentient nerves, or in fact nerves of any kind; they are, therefore, wholly insensible. On the other hand, the extremities of the fingers, the skin of which contains a close network of nervous filaments, are the most sensible parts of the whole body.

3. *Nutrition.*—The nutritive principle or force is the common property of both animals and vegetables; and is, therefore, more universally distributed than either contractility or sensibility, which are limited to the animal creation. Its operation consists in the elimination of certain substances precisely similar to those in which the power is located. In the full-grown animal, its principal object is to repair the waste which is constantly going on in every part of the body.

Development of the Tissues.—It may surprise the young student, but it is nevertheless true, that the human body, with all its apparent complexity of organs and tissues, has its origin in a minute cell, or sac, readily seen by means of the microscope, and so nearly resembling that from which the inferior animals, and even that from which some vegetables originate, that it is often impossible to distinguish them from one another. Retracing the steps by which the perfect body has arrived at its matured state, we find this primordial cell in the ovary of the female. Here it presents itself as a small spherical body, consisting of a delicate homogeneous membrane, which incloses a drop of fluid and an exceedingly minute, dark body, called the *nucleus*, or germinal spot. From this cell, or vesicle, with its fluid and nucleus, the entire animal body is developed. In order to form a clear idea of the manner in which this takes place, it is necessary to examine the analogous process in plants, in which

it is less complex and more easily studied. It was the discovery of this cell-formation in vegetables, which first led physiologists to suspect the existence of a similar development of animals.

If a drop of the juice found in the fruit of the common snow-berry or honeysuckle, is examined with a microscope of medium power, it will be seen to consist of a collection of small polyhedral or spherical cells, surrounded by a transparent fluid. Each cell is composed of a thin homogeneous capsule, which contains a colored or colorless fluid, and one or more dark granular bodies, attached to its inner surface. The surrounding fluid, called the *blastema*,* is very similar to that inclosed by the cell; and there may be observed floating in it numerous little granules, or corpuscles, precisely like those upon the inside of the cells. Now, previous to the formation of the cells, there exists, as was demonstrated by Schleiden, only the fluid or blastema, and the little granules, or *cytoblasts*,† as they are termed; but, by a mysterious, unknown power, some of these cytoblasts increase in size, and from the surface of each arises a delicate membrane, compared, by Quain, to a watch-crystal; this, continuing to enlarge, ultimately incloses the granule, which now appears attached to its inner surface (Fig. 2). In this way a perfect cell is formed; what was before a cytoblast, is now a *nucleus;* and the delicate membrane, which elevated itself from the surface of the cytoblast, has become the cell-wall. But the student may ask, whence comes the contained fluid? This is readily answered; it enters the cell from without, by diosmosis. When fully formed, the cell-wall enters immediately upon its duties; which, in general terms, consist in the absorption of the surrounding fluid, the elaboration of certain materials from it, and the rejection of others. These functions, however, are variously modified in the several species of plants. Thus, in those of the lowest order, as the mould and the yeast-plant, each cell is independent, and the entire plant is only a collection of these cells, which reproduce themselves indefinitely. But in plants of a higher organization, each primordial cell performs a particular part in the development of some special substance, which substance is itself partly composed of cells possessing a similar power. The changes which the cells undergo in thus advancing to a state of organization higher than that of simple independent organs, are very numerous; but, for want of space, they cannot

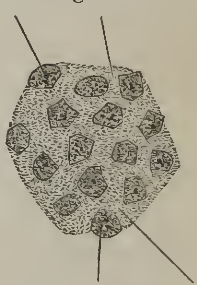
* Βλαστανω, "I bud."

† Κυτος, "a cell," and βλαστος, "a germ."

all be enumerated here. It must suffice to state: 1, that they may increase in size; 2, alter in shape so as to become polyhedral, flattened, fusiform, or tubular; 3, coalesce to form tubes, or canals; 4, become filled up by secondary deposits, and elongated into fibres; and, lastly, may generate new cells upon their interiors, in order to supply the places of the mother-cells, which, in the course of time, rupture and are absorbed.

In the animal economy, the general structure and functions of the original cells do not differ materially from those of vegetables; but the manner in which these little bodies become transformed into different tissues, requires separate mention. It has been already stated, that the original cell or cells, found in the ovary of the female, have, apparently, nearly as simple a structure as those of the vegetable mould, the simplest of all organized substances; not the least indication can be observed of the changes which they are afterwards to undergo. These cells, however, under certain circumstances, increase in number, and are arranged into groups. The cavities of some become the seat of an interstitial deposit, whose character differs in the different groups. These groups, at first irregular and misshapen, assume after a while a definite form; the deposit in their cells, meantime, changes in color and increases in consistence; and now, for the first time, may be recognized the outline of some organ or part of the future body—it may be a liver, an arm, or a leg, the distinction being yet very obscure. These changes continue, the separate divisions increase in size, become more and more consistent, and their outline still more distinct, and it is not long before some definite shape is given to the whole. In all of these various changes, cells are the active organs, but what determines their grouping and the interstitial changes that they undergo, is still a mystery, and in all probability will ever remain so.

Fig. 1.



Animal blastema containing granules, or cytoblasts, and nucleated cells.

The development of the different organs and tissues consists then only in a multiplication of cells. The manner in which this multiplication occurs, is as follows:—

1. New cells may form upon pre-existing cytoblasts, the latter becoming the nuclei of the former (Fig. 2). These nuclei may increase in size, but always less rapidly than the cell-wall, or they may disap-

pear altogether. Of the origin of the cytoblasts nothing certain is known. Schleiden and Schwann suppose that they result from an aggregation of matter around a still smaller body, called a *nucleolus;* but this is only transferring the difficulty; the question then arises as to the origin of the nucleolus.

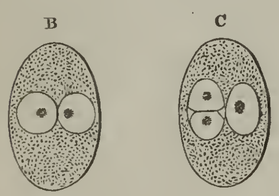
2. New cells may be generated by the nuclei of pre-existing cells (Fig. 3). In this case, several cells are usually produced by one nucleus, which, by a species of cleavage or duplication, furnishes for these nuclei new creations. The latter are at first contained within the mother cell, which, after a while, is ruptured or liquefied.

Fig. 2.

Plan representing the formation of a nucleus, and of a cell on the nucleus, according to Schleiden's view.

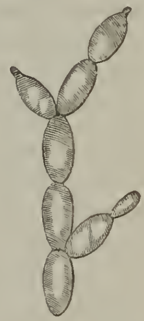
3. A new cell may be formed by the agglomeration of certain substances in the blastema, without the aid of pre-existing cytoblasts, or cells, and afterward acquire a nucleus (Schwann).

Fig. 3.



Plan showing duplication or cleavage of cells.

Fig. 4.



Magnified figure of the yeast-plant, *Saccharomyces cerevisiæ.* (After Meyen.)

4. New cells may sprout, as it were, from the sides of other cells, as is observed in the yeast-plant (Fig. 4).

Formation of Tissues from Cells.—In the production of the several tissues of the body, the cells undergo certain changes, whose nature varies with that of the tissue to be formed. As already mentioned, all the tissues of the body can be reduced to three microscopic elements; namely, molecules or granular cells, and

fibres, tubes, or homogeneous membrane, together with a quantity of amorphous matter. In the production of simple fibre, an entire transformation of the cell is necessary, which takes place in the following modes:—

1. By increasing in size, in particular directions, cells may become elongated, fusiform, or prismatic, and after the cell-wall has become thickened, may be divided into longitudinal strips, or fibres. These fibres are at first so closely adherent as to present the appearance of a single large fibre; but they soon separate; and, if a close examination is made, the nucleus, which is afterwards absorbed, will be seen lying in their midst. Where a fibre of considerable length is to be formed, a union of the extremities of several cells occurs, so that when the fibre is completely formed, there may be no break. In the development of some of the tissues, the muscular, for example, the cells are disposed in parallel rows, and uniting at their elongated extremities, ultimately form bundles of parallel fibres. But in the production of fibrous membranes, cellular tissue, and other structures, whose fibres cross each other in every direction, no such arrangement obtains, and the split extremities of the elongated cells branch out on all sides.*

Fig. 5.

Development of the areolar tissue (white fibrous element). 4. Nucleated cells, of a rounded form. 5, 6, 7. The same, elongated in different degrees, and branching. At 7, the elongated extremities have joined others, and are already assuming a distinctly fibrous character. (Schwann.)

2. While changes of figure and size are going on in a cell, its wall and inclosed matters may also become altered. Thus, for instance, the cells of the cuticle, when first formed, are soluble in acetic acid, but they soon lose this property in consequence of changes in the cell-wall. In the adipose and pigmentary tissues, the inclosed matter of the cells does not present its characteristic appearance until some time after their first development.

3. It is probable, but by no means certain, that cells having

* Henlé is of opinion that in the development of these latter tissues the blastema itself is converted into fibres without the agency of cells, or cytoblasts.

arranged themselves into rows, may form canals by the absorption of their opposed sides, instead of splitting into fibres.

Changes in the relations of cells occur in several ways.

1. Cells may remain entirely independent, and in this condition constitute an essential element of certain fluids, as in the blood, lymph, and chyle, in which they are freely suspended, as in a blastema.*

2. They may become isolated by the development between them, of fibres which soon constitute the greater part of the tissue.

3. They may become inclosed by new cells, thus forming complex cells, as already mentioned.

4. They may become arranged upon the surface of a basement membrane of a fibrous character. This is the case in the epithelia of serous and mucous surfaces.

The development of all the tissues takes place after one or more of the preceding modes, but it has been supposed by Henlé and Mandl that tissues may also originate from the blastema, and even from the nuclei.

AREOLAR, OR CELLULAR TISSUE.

The areolar† (cellular) tissue, is that soft, white, filamentous, and cotton-like substance, found in greater or less abundance in every part of the body. Examined closely, it will be seen to consist of minute threads, or filaments, crossing each other in every conceivable direction, and forming meshes, or interspaces, of various sizes and shapes, which communicate with each other on every side. In the natural condition, these interlinear spaces (areolæ) are exceedingly small, and in order to be readily seen must be distended with air or fluid. They are said to contain a minute quantity of serous or albuminous fluid, but this has never yet been obtained in a separate state, and it is most probable that it is present only in the form of a vapor, which keeps the tissue moist and soft.

Although possessing the same general characters in all parts of

* Mandl contends that the blood-globule is only a nucleus of a pre-existing cell, whose walls have become liquefied.

† The term "areolar" is preferable to "cellular," as the latter is frequently applied to structures composed of cells.

the body, areolar tissue subserves a variety of purposes, and has received different names in different situations. Thus it forms a general investment for the body immediately beneath the skin (termed the subcutaneous areolar tissue), connecting this structure to the subjacent organs, and allowing that degree of mobility which each particular region requires. Placed beneath the mucous and serous membrane, it is called respectively *submucous* and *subserous areolar tissue*, and here, too, its office is principally that of a connecting medium. Again, it forms a special covering for every separate organ, and in these situations is termed *investing areolar tissue*. Lastly, it is an essential element in the minute texture of all the compound structures, however different in general character or functions; here it is called *constituent areolar tissue*. While, therefore, in the human body this tissue is everywhere present, it has many distinct uses; being in one place a medium of attachment; in another, an investing membrane; and, in another, a constituent, or parenchymal element.

In consequence of its remarkable extensibility and elasticity, areolar tissue allows large dropsical accumulations to take place in its interstices, and returns again to its natural condition when the fluid is removed. In many situations, as beneath the skin of the arm-pits, groins, and scrotum, its texture is loose and open and easily lacerated; but, when intimate union is necessary, it is extremely dense and strong, and with difficulty torn asunder.

Areolar tissue possesses little or no sensibility. In the living subject it may be cut or torn in any direction, without producing pain, except what may arise from injury to nervous filaments passing through it to adjacent parts. The presence of these nerves will also explain the pain produced by boils and other collections of pus beneath the skin and mucous membrane. This tissue is, however, endowed with a species of vital, or organic contractility. It shrinks upon the application of certain stimuli. This property differs from muscular contractility, in not manifesting itself under the influence of electricity or galvanism, in being entirely beyond the control of the nervous system, and in disappearing immediately after death. All areolar tissue, however, is not endowed with this power; hence the division made by some anatomists into erectile and non-erectile areolar tissue. It is well seen in the wrinkling of the skin, more particularly that of the scrotum, when exposed to cold; and, also, according to Müller, in the erection of the nipple.

Areolar tissue is highly absorbent; but the rapid disappearance

of dropsical collections, which is sometimes noticed, is probably due to the vessels that pass through it, rather than to any inherent power in the tissue itself.

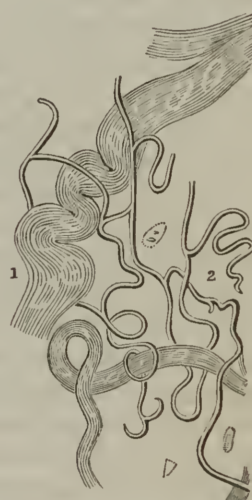
By boiling, areolar tissue may be almost entirely converted into gelatin. This is the result of a chemical change produced by the hot water; a fact that must be borne in mind, because all the organs of the body, containing more or less of this tissue, will furnish a certain amount of gelatin, when submitted to this process.

Structure.—The delicate transparent filaments and small membranous bands, recognized by the naked eye as composing the entire mass of areolar tissue, are found under the microscope to consist of still smaller filaments, which are perfectly transparent, and measuring about $\frac{1}{1500}$ of an inch in diameter. These minute fibres are arranged into various sized bundles (Fig. 6), are undulating or wavy

Fig. 6.

Filaments of areolar tissue, in larger and smaller bundles, as seen under a magnifying power of 400 diameters. Two or three corpuscles are represented among them.

Fig. 7.



The two elements of areolar tissue, in their natural relations to one another. 1. The white fibrous element. 2. The yellow fibrous element, showing the branching or anastomosing character of its fibrillæ. Magnified 320 diameters. (Todd and Bowman.)

in their direction, and always lie parallel in the same bundle. It has been also observed that, although they may pass from one bundle to another, they never anastomose or divide.

Intermixed with these white or transparent fibres, another kind has been lately demonstrated, especially in the submucous and subserous areolar tissue. They are called the yellow elastic fibres (Fig. 7), from their almost exact similarity to the compound fibre of the yellow elastic tissue. They are colorless, but have a well-defined outline; they are not collected into bundles, but mixed indiscriminately with the other variety, and are

remarkable for their tendency to curl up. In order to see them plainly, it is necessary to moisten the tissue with acetic acid, which renders the white filaments indistinct. The size of this fibre varies, being sometimes as small as that of the white, and, again, many times larger.

As previously mentioned, areolar tissue has very few proper vessels or nerves. It is not, therefore, highly organized, as, indeed, might be inferred from the readiness with which it is destroyed by inflammation; it is regenerated, however, with almost equal rapidity, surpassing in this respect all the other tissues, except the epithelial.

VASCULAR TISSUE.

This tissue, as its name indicates, consists of vessels; and, as will be understood after its structure has been described, is more properly an organ than a simple tissue. It admits of two principal divisions, namely, bloodvessels and lymphatics.

Bloodvessels.—The bloodvessels form a system of membranous elastic tubes, of various sizes, distributed throughout every organ and tissue of the body, for the purpose of circulating the blood. They are divided into two classes, arteries and veins; to which is sometimes added a third, called the capillaries. The arteries originate by two large trunks from the ventricles of the heart, from which, branching out in every direction, they conduct the blood to all parts of the body. The veins, on the contrary, commence in the remote parts of the body by small radicles, which unite to form large trunks. They communicate with the auricles of the heart, and return the blood to this, the central organ of the circulation. The capillaries are a network of delicate vessels, intermediate between the terminal branches of the arteries and the rootlets of the veins, but not properly distinct from either.

Arteries.—The arteries are of two kinds, namely, the systemic and the pulmonic. The former carry florid blood to the system at large, and the latter dark blood to the lungs. Thus, taking the heart as the starting-point, two main trunks pass off from the two ventricles of this organ, one called the pulmonary artery, and the

other, the aorta; and these, dividing and subdividing, ramify minutely, the former in the lungs, and the latter in the general system. The two may be represented, therefore, by two trees of unequal size, whose trunks, the pulmonary artery and aorta, are connected with the heart. The following remarks, however, are intended to apply more particularly to the larger or systemic tree, formed by the aorta and its subdivisions.

Division.—The mode in which arteries divide into smaller ones varies very greatly in different parts of the body, and is subject to no general laws. Thus, a single artery may *bifurcate*, *i. e.* resolve itself into two of nearly equal size, and this usually takes place at an acute angle. From a main trunk numerous small collateral branches may be given off, and thus the vessel gradually diminishes to a very small size. These collateral vessels generally come off at an acute angle, but sometimes at a right, or even at an obtuse angle, and their number does not always proportionally diminish the size of the common trunk. Again, most arteries give off branches at very short intervals; but a few run a considerable distance without furnishing a single offset, until they reach the organs for which they are intended, as, for instance, the common carotid, spermatic, and umbilical arteries. Notwithstanding these divisions and subdivisions, there is an uninterrupted communication between every part of the arterial system; this is effected by what is called *anastomosis*, or *inosculation*, which may occur through the intervention of intermediate branches, by the coalescing of two arteries to form one, or by two arteries coming toward each other and uniting in a common arch.

Direction.—The general direction of the principal arteries is straight, but the smaller divisions are always more or less flexuous. Exceptions are found in the cardiac, labial, splenic, and internal carotid arteries; which, although large, are more or less tortuous; a condition connected, in the first two of these, with the great distension and contraction to which the respective organs are subject.

Situation.—As a general rule, the principal arteries are to be found in the most protected parts of the body. Thus, in the extremities, they lie deeply upon the inner sides of the limbs, and along the flexures of the joints. They are also nearly always surrounded by more or less loose areolar tissue, especially in the great cavities of the body, and in the neighborhood of the joints.

Capacity.—The number of the successive divisions of the arteries, commencing at the aorta, is about twenty. At each one of these

divisions, with a few exceptions, there is an increase of capacity; that is to say, the united capacities of the branches exceed that of the main trunk. This increase, however, is not as great as is generally supposed, owing to the erroneous method of computation which most anatomists have adopted. This error, which was first pointed out by Cruveilhier, consists in taking the diameters of the tubes as the measure of their capacities, whereas the proper method is to take the squares of these diameters. At first thought, it would seem that this successive increase of the capacity of the arterial system—which has been ingeniously compared to a cone with its apex at the heart—would operate to retard the flow of blood in the remote branches; but, as Bichat correctly remarked, this can have but little effect in a system of communicating and permanently distended tubes.

The arteries in all parts of the body terminate ultimately in the veins. But this communication is not direct; the vessels divide and subdivide, until they become too small to be seen with the naked eye; and if they are traced out by means of a microscope, their minute division will be found forming an essential part of that network of vessels called capillaries, from which the rootlets of the veins take their origin.

Physical Properties.—The most remarkable of the physical properties of the arteries is their elasticity. This is manifested in their prompt retraction after they have been greatly extended, and in their contraction and retraction when divided. The patulous or open condition in which they are found after death also exhibits the same property.

Vital Properties.—Arteries are not endowed with sensibility, but they possess a certain degree of vital contractility. This latter property, whose existence was for a long time denied, exhibits itself in a slow, rhythmic, successive diminution of the caliber of the tube, in the direction of its terminal branches, in which it is more manifest than in the larger trunks. It is, therefore, unlike muscular irritability, which is spasmodic and irregular; and, to distinguish it from this, it is called "tonic" contraction. It may be seen in the small arteries of the web of a frog's foot, placed under a microscope, the vessels being stimulated by pricking with the point of a needle, or by the contact of some irritating fluid.

Structure.—The arteries are compound in their structure. They have three distinct cylindrical layers, or coats, which are placed one within another, and connected by areolar tissue. Besides these three

proper tunics, each artery is surrounded by a sheath of condensed areolar tissue, which, in some instances, incloses other structures also; as in the neck, where one common sheath surrounds the carotid artery, jugular vein, and pneumogastric nerve. The medium of union between the sheath and its included artery is loose areolar tissue, which allows the vessel, when cut across, to retract a considerable distance within.

The *external coat* of the artery is a dense, strong membrane, somewhat resembling the sheath. It consists principally of closely interwoven filaments of areolar tissue. Its thickness varies in different parts of the body, but it is proportionably greater in the small than in the large branches. In the arteries of the uterus, and in some other instances, it is entirely wanting. It is best seen in the large trunks, from which it can be readily dissected. Although it may be considerably extended, it has no elasticity. It is upon this layer that the strength of the vessel mainly depends; and, in the application of the ligature, it is the only one of the three that remains intact, the two others being completely divided, if the knot is firmly drawn.

By means of the microscope, the external coat may be resolved into two distinct laminæ; an internal, of genuine elastic tissue, and an external, of common areolar tissue, closely condensed.

The *middle coat* is the thickest of the three, although varying very greatly in thickness, in different parts of the system, and like the external, it is sometimes entirely wanting. It is of a reddish-yellow color, firm, and rather dry; and consists of distinct fibres, disposed in a circular, or spiral manner around the vessel. In the large arteries it may be divided into many layers, united to each other by short areolar tissue, and by an interchange of fibres. In the small branches, it consists of only a single layer, too thin to be divided, although it forms the chief thickness of their walls. Its most remarkable property is its elasticity, which exceeds that of any other tissue in the human body. It is principally owing to the firmness and elasticity of this coat, that the arteries remain patulous after death, and contract and retract when divided.

Under the microscope, the fibres of the middle coat are found to be of two kinds; the one consisting of fine, yellow, elastic filaments (Fig. 7), joined together in an irregular network; and the other, of pale, soft, translucent fibres, measuring about $\frac{1}{4000}$ of an inch in diameter, and presenting here and there the remains of nucleated

cells; the latter belong in all probability to the class of involuntary muscular fibre.

The *internal*, or *serous coat* lines the internal surface of the middle coat, to which it is intimately connected. It is very delicate, smooth, almost transparent, tolerably elastic, yet easily torn; and, unlike the two other coats, has a free surface for contact with the blood. At the mouth of the aorta this membrane forms three folds, called the semilunar, sigmoid, or aortic valves, whose office is to prevent the reflux of the blood into the left ventricle of the heart. In other situations, we sometimes find small longitudinal, or even transverse folds, which are produced by the contraction of the artery, and disappear when it is distended.

This coat is so closely adherent to the preceding that it cannot be readily dissected. Under the microscope, it will be seen to consist of two distinct laminæ. The internal lamina is a tessellated epithelium (see art. *Epithelial Tissue*); the other seems to be made up of very minute, pale fibres, which follow a longitudinal direction, and anastomose obliquely. It is remarkable for numerous small oval perforations; from which it has been named, the "perforated," or "fenestrated membrane."

The walls of the arteries are plentifully supplied with arterial blood, by numerous small arterial twigs, called *vasa vasorum*, which do not usually come from the vessels to which they are distributed, but from neighboring branches. They divide very minutely in the sheath and cellular coat, and some of the smallest enter the middle coat, but none have ever been traced into the internal. These vessels, with the little venous radicles in which they ultimately terminate, form an intricate network in the outer part of each of the arteries, even to their smallest subdivisions.

The arteries are entirely devoid of sensibility; and it is, therefore, probable that they receive very few, if any, nerves from the cerebro-spinal system; but that they are abundantly furnished with filaments from the sympathetic system, not only in the splanchnic cavities, but also in the extremities, there can be little or no doubt.

VEINS.—The veins are distributed throughout every part of the body, for the purpose of receiving the blood and returning it to the heart, after it has passed through the arteries and undergone certain changes in its course. They commence by minute radicles which unite to form larger branches, or trunks, and ultimately terminate in the right auricle.

Like the arteries, the veins belong to two general classes; the one, called "pulmonary," originating in the lungs, and terminating in the left auricle; the other, named "systemic," commencing in the body at large, and opening into the right auricle. The blood conveyed by the pulmonary veins is florid, or arterial, and that by the systemic division, venous, or dark blood.

The veins are much more numerous than the arteries; they are also more capacious, and their anastomoses are larger and more frequent. They are conveniently divided into two sets—a superficial and a deep—names which sufficiently indicate their relative position. The *superficial*, or *subcutaneous veins*, are most numerous and largest in parts where the circulation in the deep set is liable to be obstructed by muscular contraction; as, for instance, in the extremities, where they form a collateral route for the blood.

The *deep veins* accompany the arteries, and are hence called the *satellite veins* (*venæ comites*); the largest arteries have generally one, and the medium-sized two, one on each side. They are contained in the same sheath with the arteries, to which they are connected by areolar tissue, sometimes so closely as to require great skill to dissect them apart. In the dura mater, liver, and some other deep structures, the veins do not attend the arteries.

The anastomoses between the veins are in all situations large and numerous, and particularly so in parts where the circulation is liable to obstructions; as, for example, around the neck of the bladder and lower portion of the rectum, where they form a most intricate network, or plexus.

The course of the veins, like that of the arteries, is generally straight; but to this there are numerous exceptions, the most remarkable example of which is seen in the veins of the gravid uterus.

Structure.—The walls of the veins are much thinner than those of the arteries; and hence, when empty, they do not retain their cylindrical form, but collapse. They are composed, however, with some exceptions, of three coats, or tunics.

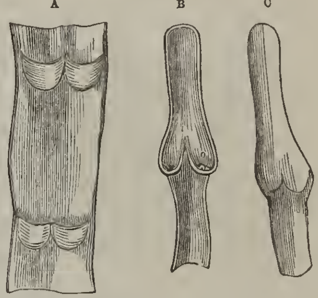
The *external coat*, although dense and strong, is somewhat thinner than that of the arteries, to which it is exactly similar in structure.

The *middle coat* is but poorly developed, and in many places cannot be demonstrated at all; but, as a general rule, is thicker in the superficial than in the deep veins, and in the large trunks of the splanchnic cavities than in those of the extremities. It is composed of fibres, which are of two kinds, and arranged for the most part

circularly around the vessel. One consists of plain, white filaments, like those of areolar tissue ; the other, which is much less abundant, of nucleated filaments, like those in the middle coat of the arteries, and belongs evidently to the plain variety of muscular fibre.

The *internal coat* is the essential constituent of the veins, and is sometimes the only one present. It does not differ in structure from the analogous arterial coat, but is somewhat less brittle, and can be dissected off in much larger pieces. In different parts of the venous system this coat forms transverse folds, called "valves," (Fig. 8;) which are of a semilunar shape, with their free margins directed toward the heart. They are intended to support the blood, when the circulation propels it in a direction contrary to its own gravity; and, in other situations, to prevent a reflux of this fluid. Valves are not present, however, in all the veins; but, as a general rule, they are found only in those situations where there are natural obstructions to the ready return of the blood to the heart; and where these difficulties are greatest, the valves are most numerous. In veins of a medium size, the valves generally occur in pairs, but in those of smaller caliber they are single; while in those of very small size they are entirely wanting. They are also wanting in the veins of the viscera, of the bones, of the dura mater, and in the two cava veins.

Fig. 8.



Diagrams showing valves of veins. A. Part of a vein laid open and spread out, with two pairs of valves. B. Longitudinal section of a vein, showing the apposition of the edges of the valves in their closed state. C. Portion of a distended vein, exhibiting a swelling in the situation of a pair of valves.

The walls of the veins, like those of the arteries, are provided with small nutrient vessels (veins and arteries, *vasa vasorum*); they are supposed also to have nerves, whose filaments have, in fact, been demonstrated in one or two of the larger trunks. They possess no sensibility, but in recently killed animals are said to exhibit well-marked vital contractility, which is doubtless due to the pale muscular fibres found in their middle coat.

Capillaries.—The capillary vessels are intermediate between the arteries and veins, and are properly the terminal branches of the former, and the rootlets of the latter. They exist in every organ, and in nearly every tissue of the body, communicating freely

with each other, and forming an intricate network, or plexus, whose interstices vary in their size and shape in different parts.

The size of the capillary vessels is not uniform. It is generally greater than that of the blood-corpuscle, so as to allow the passage of more than one of these bodies at the same time. The existence of capillaries so small as to admit the circulation of only the serous parts of the blood, is not at the present day generally admitted by anatomists.

The closeness of the network formed by the anastomoses of the capillaries, is generally in proportion to the importance and activity of the function of the organ, or tissue. In the lungs, muscles, skin, and glandular organs generally, the interspaces are very small; but in tendons, ligaments, and other tissues of a low degree of vitality, they are relatively quite large. The shape of the interspaces also varies, being either oblong, round, or polygonal, according to the arrangement of the minute particles of the texture.

Fig. 9.

Plan representing the terminal twig of an artery, and a venule with capillaries intervening.

Structure.—In the smallest capillaries (those that have a diameter of about $\frac{1}{3000}$ of an inch, or less), the walls seem to consist of a single, transparent, homogeneous membrane, whose external surface presents numerous oblong nucleated cells, arranged with their long axes corresponding to that of the vessel. In those of larger size an epithelium may be discovered upon the internal surface of this homogeneous membrane; and, upon its external surface, a thin coat of condensed areolar tissue.

It is most probable that the capillaries possess vital contractility, but this has not yet been clearly demonstrated, although they have long engaged the closest study of physiologists.

Absorbents, or Lymphatics.—These are a set of minute vessels that originate in the remote parts of the body, and terminate by two main trunks in the veins of the neck. They are divided into two classes; the lymphatics, properly so called, and the lacteals. The former are distributed throughout the body at large, and contain the lymph; the latter are connected with the intestinal canal, for the purpose of taking up the chyle. On account of their small

size, the thinness of their coats, and the transparency of the fluid which they contain, they are not readily seen with the naked eye; but, with an ordinary magnifying-glass, they may be discovered threading their way through almost every organ and tissue of the body. The only organs in which they have not yet been detected are the brain, spinal cord, placenta, and fœtal membranes. Like the veins, they are considered as consisting of a superficial and deep set. The former are situated in the areolar tissue, beneath the skin and the membranous envelops of the organs; the latter are in company with the large bloodvessels and nerves.

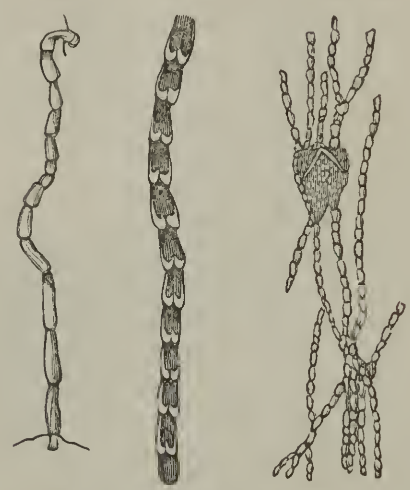
Origin.—But little is as yet known of the origin of the lymphatics; we only know that the minute radicles of those placed beneath the skin and mucous membranes form, in these situations, an intricate plexus, from which single vessels pass off, and, after penetrating the little bodies called lymphatic glands, they unite with other branches to terminate in one of the two large trunks. In the substance of the intestinal mucous membrane, however, radicles of the lacteals have been often traced into the villi, where they form a simple anastomosis; but the exact manner in which they begin, whether by open mouths, as has been supposed by many, or by blind extremities, has not been determined.

Termination.—The principal of the two large trunks of the lymphatic system is called the *thoracic duct.* It commences by a slightly dilated extremity, named the "chyle receptacle," (*receptaculum chyli,*) in the posterior part of the abdomen, lying upon the front of the lumbar vertebræ, between the inferior cava vein and the aorta. It ascends along the front of the spine into the cavity of the thorax; in the upper part of which it bends forward, and to the left, passes behind the left clavicle, and there opens into the confluence of the corresponding internal jugular and subclavian veins. The other trunk is much smaller, and is situated upon the lower part of the right side of the neck, where it also opens into the great veins.

The *lymphatic glands* are small, oval, fleshy-looking bodies, lying in the course of the lymphatic and lacteal vessels; and found in greatest numbers upon the sides of the neck, between the two layers of the mesentery, and in the thorax, arm-pits, and groins. Their size varies from that of a grain of wheat to that of an ordinary white bean. They consist essentially of divisions of the vessels arranged in a tortuous manner, bound together by areolar tissue,

and freely supplied with bloodvessels. Upon entering one of these glands, the lymphatic divides into small branches (Fig. 10, *c*), which

Fig. 10.



a. Lymphatic vessel. *b*. Another lymphatic vessel, showing the arrangement of the valves. *c*. Lymphatic vessels connected with a lymphatic gland.

are coiled upon each other, and unite again in the opposite part of the gland, to form a single vessel, which then continues on to one of the main trunks. Although apparently essential to the lymphatic system; these glands are not connected with all the vessels; and, in some instances, the same vessel passes through two or three glands. Their office is not known.

Structure.—The lymphatics are much smaller than the arteries and veins, but larger than the capillaries. Their walls are exceedingly thin, but anatomists generally admit two, and some even three coats. The *external coat* consists principally of condensed areolar tissue; it is yielding, but strong, and bears a close resemblance to the areolar tunic of the bloodvessels. The internal coat is thin, delicate, and transparent, and seems to be little else than a simple layer of scaly epithelium lining the external coat. Like the lining membrane of the veins, this coat is thrown into numerous, transverse, semilunar folds, or valves, for strengthening the vessels, and preventing the regurgitation of the lymph. These valves generally occur in pairs, but are also frequently single; and are found for the most part at the points where the vessels unite. The presence of

these valves accounts for the knotted appearance of the vessels when injected with mercury (Fig. 10, *b*).

The lymphatics, like the bloodvessels, are supplied with minute nutrient arteries and veins (*vasa vasorum*). They also possess vital contractility, as may be shown in animals immediately after death, by the application of electricity, or even by the contact of cold air.

THE CHYLE, LYMPH, AND BLOOD.

Chyle and Lymph.—The chyle is an opaque, milky-looking, viscid fluid, contained in the lacteal vessels, which receive it from the stomach and small intestines, where it is formed. It has frequently a pinkish color, which is said to be heightened on exposure to the air, or to oxygen gas. It possesses little or no odor, and a very slightly alkaline taste. When drawn from the living body, it coagulates spontaneously, a phenomenon that is due to its fibrinous element; and as the fluid contains a greater proportion of fibrine after it has passed through the lymphatic glands, so in this condition its coagulation is more rapid and the clot firmer than when it has been obtained from the vessels in the first part of their course.

Besides this increased coagulability, the appearance of the chyle is somewhat altered after the fluid has passed the lymphatic glands; the opacity in a great measure disappears, and the pinkish hue becomes more marked, or is replaced by a yellowish tinge.

Composition.—The following is Dr. Rees's analysis of the chyle of the ass, drawn from the lacteals just before their entrance into the thoracic duct, and, of course, after they had passed through the mesenteric lymphatic glands:—

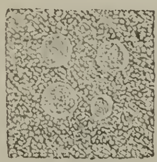
Water	90.237
Albuminous matter	3.516
Fibrinous "	.370
Fatty "	3.601
Extractive and saline matter	2.276
	100.000

Dr. Rees also examined the contents of the thoracic duct of an executed criminal, an hour and a half after death, and found it to contain less water, more albumen, less extractive matter, and much less fat than that of the ass; but, as the individual had taken little

or no food for some hours before execution, this can hardly be considered as a fair analysis.

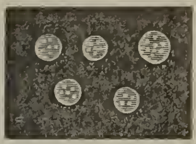
Examined with the microscope, the chyle is found to consist of a clear, transparent fluid, or "plasma," holding in suspension three kinds of solid matter: 1. Pale, colorless corpuscles (Figs. 11, 12),

Fig. 11.



Molecular base of chyle with chyle-globules. (From Dr. Gulliver.)

Fig. 12.



Perfect chyle-corpuscles. (After Wagner.)

of a rounded and slightly flattened figure, about $\frac{1}{3000}$ of an inch in diameter; they are composed of a delicate homogeneous membrane which incloses a transparent fluid, and two or three minute granules united so as to form a single dark-looking spot, or "nucleus;" 2. Numerous separate granules floating in the plasma; and 3. A few oil-globules and small spherical bodies, supposed by Gulliver to be of an albuminous nature. The clear liquor, or plasma, holds the fibrine in solution; and this, upon coagulating, incloses most of the solid constituents in its meshes, leaving a thin serous fluid, composed of water, fatty matter, salts, and extractive.

The origin of the corpuscles of the chyle is not yet positively determined; but it is most probable that they are formed by an agglomeration of solid matter around one or more of the granular molecules, which becomes in time the nuclei of the corpuscles, or cells.

The *lymph* is a thin, pale yellow, clear fluid, contained in the lymphatic vessels properly so called. Like the chyle, it has a slight alkaline reaction, assumes a pinkish color upon exposure, and separates spontaneously into a firm gelatinous clot, and a surrounding yellow fluid, about the consistence of thin cream. Examined with a microscope before coagulation, it seems to be composed of the same constituents as the chyle; the only difference being in the oil-globules, which are less numerous than in the latter fluid. The coagulation of the lymph, like that of the chyle, is due to its fibrinous constituent, which is held in solution by the liquid plasma, or blastema.

The chemical composition of a quantity of lymph drawn from a vessel upon the instep of the foot, was found by Marchand and Colberg to be—

Water	96.92
Fibrin*	.52
Albumen	.43
Fatty matters	.27
Osmazome, and various salts . . .	1.86
	100.

The Blood.—The blood is contained in the heart and blood-vessels; and, to the naked eye, is a homogeneous fluid, of a bright red color in the arteries, and a deep purple hue in the veins. Its specific gravity varies from 1050 to 1060, water being 1000; and its temperature from 96° to 100° F.; it has a weak alkaline reaction, a saltish taste, a peculiar faint odor, and a clammy or sticky feeling when rubbed between the fingers. Its quantity varies in different individuals, at different ages, and under different general conditions of the body. According to Valentin (whose experiments upon this point are probably the most careful that have ever been made), it amounts to about three-sevenths of the weight of the individual; but by some modern physiologists it is thought not to exceed thirty pounds. When drawn from the body it soon thickens, or coagulates, and separates into two parts, the one a firm, elastic, solid substance, of an intensely red color, the other a thin watery fluid, of a pale yellow tint. The solid substance is called the *clot*, or *crassamentum*, and the fluid in which it floats, the *serum*, or *serosity*. The time required for this change varies from a few seconds to eight or ten minutes, according to the state of the blood itself, the manner in which it is drawn, the size and shape of the vessel, the temperature of the surrounding atmosphere, and several other circumstances that cannot be here enumerated. Blood obtained from persons of a full plethoric habit coagulates more slowly than that taken from those who live abstemiously. When the blood is drawn from a large orifice, and received into a deep cup, the process is comparatively tardy; but if the orifice is small, and the receiving vessel shallow, it is almost immediate, and this is especially the case when the air is very warm. Arterial

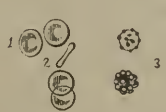
* The fibrin is in all probability more abundant in vessels nearer the central trunks.

blood coagulates more rapidly than venous, and that of the female a little sooner than that of the male.

Microscopic Characters.—Under a microscope of medium power, the blood may very readily be seen to consist of an almost colorless fluid, holding in suspension numerous little corpuscles or globules. The clear fluid, commonly called the plasma, or blood liquor (liquor sanguinis), is the coagulable part of the blood; it is composed of water, fibrin, albumen, and various salts. It must not, therefore, be confounded by the student with the serum, which is almost destitute of fibrin, and on that account does not coagulate spontaneously. The corpuscles or solid parts are of two kinds, the colored and the colorless; or, the red and the white, as they are usually distinguished. The latter, owing to the smallness of their number, are often difficult to discover, and it has been only within a very few years that anatomists have acknowledged their existence in human blood. In the frog and some other animals they are found in great abundance.

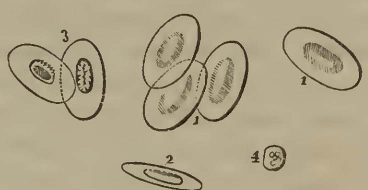
The *red corpuscles* vary in shape and size in the different genera and species of animals. In man, they are not actually globules, but small circular disks (Fig. 13), like coins, with a slight depression at

Fig. 13.



Red corpuscles of human blood, magnified about five hundred diameters (Wagner). 1, shows depression on the surface. 2. A corpuscle seen edgewise. 3. Red corpuscles altered by exposure.

Fig. 14.



Corpuscles of frog's blood, magnified about five hundred diameters. 1, 1. Their flattened face. 2. A corpuscle turned edgewise. 3. A lymph-globule. Blood-corpuscles altered by dilute acetic acid.

the centre of each surface. They are, therefore, thicker at their margins than in the middle; and, when looked at edgewise, resemble a double concave lens with rounded margins.* It must be men-

* This depression upon each surface gives to the centre of the corpuscle a shaded appearance, which is supposed to explain the error, committed by many, in admitting the presence of a nucleus.

Since writing this note, Prof. Palmer, of the University of Louisville,

tioned, however, that this bi-concave shape is much more evident in blood that has been drawn some minutes, than in that just from the body. Mandl states that he has seen it produced in corpuscles while under examination. It is well known that the corpuscles alter upon exposure, and that very soon; becoming shrivelled, contracted, and sometimes jagged at the edges—changes which are due to the transudation and evaporation of the aqueous portion of their contents. This fact may be easily proved by placing them in pure water or acetic acid, when they will be observed to swell out, become very indistinct, and presently burst. The size of the red corpuscle differs, not only in different classes and species of animals, but also in the different individuals of the same species. In the human subject they are about $\frac{1}{3500}$ of an inch in diameter, and one-fourth less in thickness. Among mammalia, the largest are found in the elephant, and the smallest in the Napaul musk deer (Gulliver). In the former, they measure $\frac{1}{2700}$, and in the latter $\frac{1}{12000}$ of an inch in diameter. In birds, reptiles, and fishes, they are much larger; those of the frog (Fig. 14), for instance, are of an oval figure, and in their longest diameter measure about $\frac{1}{1000}$ of an inch.* Each corpuscle consists of an envelop and an inclosed matter. The envelop, called the *capsule*, is a thin, delicate, transparent, and apparently homogeneous membrane, insoluble in water, but readily dissolved by ether and strong alkaline fluids. The inclosed substance, in which is contained the coloring matter of the blood, is a semifluid, of a pale yellowish-red tint, sometimes obscurely granular, and, in the frog, surrounds a well-marked nucleus.

The *white corpuscles*,† or, as they are sometimes called the lymph-globules (Fig. 14, 4), do not exist in great numbers in the blood of mammals, only one or two being generally seen in the field of the microscope; but they are very abundant in that of the naked reptiles, in whose transparent parts—as the web of a frog's foot or the fin of a fish—they may be distinctly seen rolling along with the others. They are spherical, perfectly transparent, and colorless; in man they are a little larger, and in reptiles much smaller than the red corpuscles. Immersed in water or acetic acid they en-

has assured me that, with a twelfth object-glass, recently made for him by Spencer, of New York, he has clearly demonstrated the existence of a granular nucleus in the centre of the human blood-globule.

* The corpuscles of the proteus and siren, belonging to the same class of animals as the frog, are said to be $\frac{1}{400}$ of an inch in length.

† The lymph-corpuscles were first discovered by Müller, in 1837.

large, exhibit a delicate capsule, rupture, and release one or more minute granules. These are in all probability the same corpuscles that are found in the chyle and lymph, and are supposed to be ultimately transformed into red disks.

Besides the colored and colorless corpuscles, the blood sometimes contains oil-globules, and also minute granules or molecules. The nature of the latter is not ascertained.

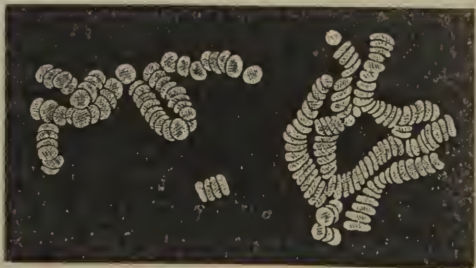
Chemical Composition.—The *proximate chemical constituents* of the blood, according to Lecanu, are about fourteen in number; of which the principal are water, albumen, fibrin, hematosin or coloring matter, extractive matter, and various salts. The number of *ultimate* elements has been variously estimated, but the most important are oxygen, hydrogen, carbon, nitrogen, sodium, potassium, calcium, iron, silica, and manganese. The substances which most interest physiologists and pathologists, are the red corpuscles, fibrin, albumen, salts, and water. The relative proportions are stated by Lecanu as follows:—

Red corpuscles	127
Fibrin	3
Albumen and other dissolved animal matters	72
Salts	8
Water	790
	1000

These numbers are not the same in all individuals. Andral found the red corpuscles to vary, within the limits of health, from 110 to 140; the fibrin from $2\frac{1}{2}$ to $3\frac{1}{2}$; pure albumen from 68 to 70; and water from 790 to 800.

The *red corpuscles*, as already stated, are distinct bodies, or rather

Fig. 15.



Rolls of blood-corpuscles. (After Donné.)

organs, floating in the blood-liquor or plasma, to which they doubt-

less bear the same relation as cytoblasts to blastema. In recently drawn blood the individual corpuscles manifest a remarkable attraction for one another, and may be observed to run together so as to form rolls resembling piles of coin (Fig. 15). They constitute by far the largest part of the organic matter of the blood, and yield, on analysis, 1, fibrin; 2, a colorless substance nearly allied to albumen, called globulin; and 3, a coloring principle named hematosin or hematin.

The *fibrin* of the blood exists in solution in the blood-liquor, and is distinguished from albumen, which it closely resembles in composition, by its spontaneous coagulation. It is not, probably, so actively engaged as the red corpuscles in carrying on the great functions of respiration and circulation, by which the animal temperature is maintained, and life and vigor given to every organ and tissue; but its office, not less important because more obscure and quiet, consists in nourishing and repairing the structures, and furnishing them the power to perform their several offices. When obtained in a separate state by stirring fresh blood with a bunch of twigs, or by washing the clot, it is found to be a white, soft, stringy substance, elastic to a moderate degree, of about the consistence of boiled maccaroni, and entirely devoid of taste or smell. Being largely increased in quantity in inflammatory states of the system, it forms upon the surface of blood drawn under these circumstances a distinct layer, called the "buffy coat." This is often quite tough and firm, and may be dissected off from the clot in the form of a membrane which varies from the most delicate film to a fourth or even half an inch in thickness.

It is insoluble in water, alcohol, and ether, but is readily taken up by solutions of the caustic alkalies, destroying at the same time their alkaline properties. According to Dumas, its composition is 52.78 carbon, 6.96 hydrogen, 16.78 nitrogen, and 23.48 oxygen. Reduced to ashes, it furnishes phosphate of lime, and a little phosphate of magnesia.

The *albumen* may be obtained from the serum in which it is dissolved, by heat, or by precipitation with alcohol. Freed from all foreign matters, it is an opaque, white, homogeneous substance, soft but elastic, insoluble in water, but rapidly dissolved by the caustic alkalies. Aside from its giving to the serum a consistence that fits this fluid for circulation, and for the suspension of the red corpuscles, it seems to be the material from which fibrin is elaborated, and this is probably its chief use in the animal economy. Its composition is,

carbon 54.38, hydrogen 7.14, nitrogen 15.92, oxygen 22.56, and a small quantity of sulphur and phosphorus.

The *oily* or *fatty matters* of the blood are found principally in the serum, although a small quantity may also be obtained from the fibrin and red corpuscles. It may be easily separated by adding to the serum about one-third of its bulk of ether, with which it readily mixes. According to Lecanu, its usual proportion is about 5.15 to the 1000 of blood; but its quantity is variable, and is sometimes so greatly increased as to give to the serum a turbid, milky appearance.

The *salts* of the blood are—1. Combinations of soda, potassa, and ammonia, with muriatic, lactic, carbonic, phosphoric, and sulphuric acids; 2. Combinations of lime and magnesia with phosphoric, carbonic, sulphuric, and lactic acids. Their presence is essential to the preservation of the red corpuscles in their natural shape and size; and, probably, also to the fluidity of the fibrin, and the due oxygenation of the blood in the lungs.

The *water* of the blood, as previously mentioned, forms about 790 parts in 1000; but it is obvious that this proportion will be increased or diminished according to the variations of the other constituents.

According to the experiments of Bischoff and Magnus, the blood holds in solution, as it were, certain quantities of oxygen, nitrogen, and carbonic acid gases, which, as the following table from Magnus indicates, vary in their relative properties in the two kinds of blood:—

Gases.	Arterial blood.	Venous blood.
Carbonic acid	7.10	5.35
Oxygen	2.65	1.21
Nitrogen	1.35	1.13

NERVOUS TISSUE.

The nervous tissue, constituting what is generally termed the nervous system, is a soft, white, or grayish substance, forming in certain situations large masses denominated nervous centres, from which it is prolonged into all parts of the body in the form of cords called nerves. These two divisions bear nearly the same relation to each other that exists between the bloodvessels and the heart. The central masses are *axes* of power; they receive impres-

sions from different parts of the body through the medium of the nerves; they originate influences excited by these distinct impressions, which influences, according to their nature, may or may not be conducted off by the nerves; and, lastly, they are the seats of functions of a spontaneous or involuntary nature (intellectual functions). The nerves forming the *peripheral* portion of the system are almost entirely passive; they are simply conductors, conveying influences or impressions to and from the centre, and are hence said to be internuncial, or message-bearing.

The nervous system, as was first pointed out by Bichat, is susceptible of division into two great systems, called the animal and the organic; both consisting of central and peripheral portions. The *animal system* has for its centre the brain and spinal cord (cerebro-spinal axis); and, for its periphery, forty-three or four pairs of nerves, which are distributed to the skin, the organs of the senses, and the voluntary muscles; upon the animal system, depend sensation, perception, and volition. The *organic* or *sympathetic system* has several centres, which consist of small fleshy-looking bodies called ganglia, situated for the most part immediately in front of the spinal column. By means of connecting filaments, they form a chain or series extending from the skull to the coccyx. The nerves, or peripheral portion of this system, are distributed to those organs and tissues whose functions (nutrition, secretion, &c.) are directly concerned in the maintenance of the body, and which are, to a certain extent, performed independently of the mind.

The nervous tissue is composed of two very different structures; one called the white, fibrous, or medullary substance, and the other the gray or cineritious; names derived from appearances recognized by the naked eye.

The *white substance* is tolerably firm, resisting, and inelastic; and, in the animal system, constitutes nearly the whole of the nerves, and the greater portion of the central axis. In the former situation, it appears in the form of threads or filaments, bound together in bundles of various sizes; but in the latter, it is a consistent cheesy-looking mass, which exhibits its fibrous structure only after it has been hardened in alcohol, or some other fluid capable of coagulating its albumen.

The *gray* or *cineritious substance* exists in greatest abundance in the cerebro-spinal axis, the ganglia, and the sympathetic nerves. In all these situations, except the last, where it presents a fibrous appearance, it is a soft, inelastic, nearly semifluid mass, apparently homo-

geneous in structure, but, as will be hereafter mentioned, composed of gray fibres and nerve-cells (ganglionic cells).

The essential vital property of the nervous system, and that which belongs to it exclusively, is sensibility or impressibility; it is probable, however, that only the nerves are thus endowed; for it is found that the same impressions which give rise to pain, when made upon the peripheral portion of the system, are not perceived when made upon the brain. This has been clearly proved by the observations of surgeons in cases of wounds of the brain, and also by the experiments which Flourens and others have made upon the inferior animals by slicing, pricking, and even burning the brain, in none of which was there any manifestation of sensibility.

Chemical Composition.—The nervous system is remarkable for being the only tissue of the body in which phosphorus has been detected. It was first discovered by Vauquelin, and is stated by Couerbe to exist in combination with the fatty substances, of which he enumerates four varieties, distinguished by the names *cerebrote*, *stearoconote*, *cephalote*, and *eleencephol*. This chemist has also found that the proportion of phosphorus in the brains of idiots is less than in the brains of ordinary individuals. The great bulk of the brain, however, is water, holding albumen in solution. The following analysis of human brain is from Vauquelin.

Water	80.00
Albumen	7.00
White fat	4.55
Red fat	.70
Osmazome	1.12
Phosphorus	1.50
Acids, salts, and sulphur	5.13
	100.

Structure.—The microscopic elements of the nervous tissue, independent of its enveloping membranes and ordinary areolar tissue and bloodvessels, are fibres and cells. The fibres comprise all the peripheral parts of the system; the cells exist only in those parts of the centres which are composed of gray substance.

The fibres are of two kinds, the white or tubular and the gray; and, in proportion as one or other of these varieties abounds in a nerve, it is designated as a *white* or *gray* nerve. Thus, in the

cerebro-spinal or animal nerves, the number of white fibres far exceeds that of the gray; but in the organic or ganglionic nerves the reverse is the case, and by this means these two kinds of nerves can generally be distinguished from each other. The white or tubular fibres form also the great mass of the medullary matter of the brain and spinal cord, while the gray predominate in the cineritious parts of these centres, and in the ganglia of the organic system.

The *white* or *tubular fibres* consist of (1), a membranous cylinder; (2) within this, a white substance, called the medullary sheath; and (3), a transparent matter occupying the centre, named the axis or primitive band. It is probable, however, that the medullary sheath and the axis are one and the same substance, the white appearance represented by the former resulting from a kind of circumferential coagulation. Be this as it may, the fibres, when largely magnified, present the appearance of a tube with a double contour, and an inclosed transparent substance, which upon exposure becomes obscurely granular. The size of these fibres varies from $\frac{1}{12000}$ to $\frac{1}{1500}$ of an inch in diameter. As usually seen they have not a uniform outline, but appear dilated or swollen out at some points, and contracted at others (Fig. 16). This *varicose* condition is supposed to be caused by pressure or traction during the manipulation that is necessary for their exhibition, the soft matter within the tube being made in this way to accumulate at different points. These fibres never anastomose or divide into smaller fibres, but continue unbroken from their origin in the centres to their ultimate distribution in the tissues.

Fig. 16.

Varicose tubular or white nerve-fibre. (After Todd and Bowman.) 1, 2. The natural aspect; at 3, the white substance and axis cylinder are interrupted by pressure, at the same time that the tubular membrane remains entire; at 4, the fibre assumes a knotted character in consequence of mechanical displacement of the neurine. These varicose enlargements were thought by Ehrenberg to be natural and to exist during life; but later observations prove them to be altogether factitious.

The *gray fibres** (Fig. 17) are most abundant in the cineritious substance of the cerebro-spinal axis, and in the organic nerves; they exist also, but in small numbers, in the nerves

* Called by Carpenter, *organic nervous fibres*, and by Henlé, *gelatinous neurine*.

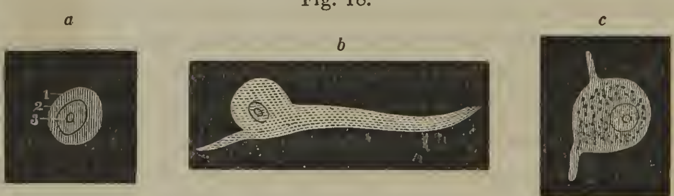
of animal life. Their exact nature is not yet determined, but they seem to be solid, homogeneous, flattened, transparent filaments, with numerous minute nucleated corpuscles lying upon their external surfaces. They have little or no tendency to become varicose, and are rather more consistent and tenacious than the tubular fibres. Their diameter varies from $\frac{1}{6000}$ to $\frac{1}{4000}$ of an inch.

Fig. 17.

Gelatinous or gray fibre, magnified 320 diameters.

The *nerve-cells*, or *vesicles* (Fig. 18), are found principally in the gray matter of the brain and spinal cord, and in the ganglia of the sympathetic system. They are dark-looking, spherical, or elongated bodies, consisting of a cell wall, an inclosed grayish matter, and a vesicular nucleus containing a well-marked nucleolus. Some of them have one or more long filamentous processes running off from their circumference, and

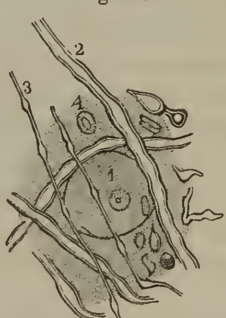
Fig. 18.



a. Spheroidal cells of vesicular neurine. (From Todd and Bowman.) 1. Cell. 2. Nucleus. 3. Nucleolus. *b*. Caudate cell of vesicular neurine. *c*. Another form of caudate cell.

are thence called caudate cells. Their size varies from $\frac{1}{3500}$ to $\frac{1}{300}$ of an inch in diameter. They generally lie imbedded in the

Fig. 19.



Blended vesicular and fibrous neurine. 1. Vesicular globule with its nucleus and nucleolus. 2. Nerve-tube, slightly varicose, and in close contact with the cell. 3. Smaller nerve-tubes. These parts all lie in a finely granular matrix, interspersed with nuclei, 4. (Todd and Bowman.)

interstices formed by the nerve-fibres (Fig. 19), and are surrounded by a granular-looking gelatinous substance which is probably their blastema. Other kinds of nerve-cells are also said to be found in the nervous tissue, but they are in all probability the same as the preceding, only less matured.

It only remains to present a brief outline of the arrangement of the preceding elementary parts in the central and peripheral portions of the nervous system, commencing with the cerebro-spinal axis.

The CEREBRO-SPINAL AXIS, the centre of the animal system of nerves, is contained in the cranium and spinal canal, where it is surrounded by three proper envelops; and, in the latter situation, by a considerable quantity of loose areolar and adipose tissue. For convenience of study and reference, it is divided into two portions; called, respectively, the spinal cord and the encephalon. The latter comprises the medulla oblongata, cerebellum, and cerebrum. Each of these parts is composed of gray or cineritious, and white or medullary substances, but the relative position and arrangement of the two are not the same in different situations.

In the spinal cord, the gray substance, although not so abundant as the white, forms a continuous central mass or axis from one end of the cord to the other. It consists of numerous large caudate cells, and of gray and white fibres. The cells contain large nucleolated nuclei, surrounded by a shaded and sometimes dark granular matter, and many of them have long filamentous processes, branching out in different directions. The pale or gray fibres, easily recognized by the corpuscles on their surface, run for the most part in a longitudinal direction, and are noticed to lie remarkably close to each other. The tubular fibres are derived from the surrounding medullary substance of the cord, and the roots of the spinal nerves; they are numerous, and have also a general longitudinal direction.

The white substance of the cord is much more abundant than the inclosed gray matter which it surrounds on all sides. It consists almost entirely of tubular fibres, which are somewhat smaller than those of the nerves, and arranged in longitudinal bundles. There are, in all probability, two sets of these fibres; one derived from the nerves and continued into the encephalon, the other limited to the cord and extending from one part of it to another, for the purpose of associating or connecting the different portions of the gray substance.

In the encephalon, the gray substance is found principally in two situations. It covers the whole of the external surface of the cerebrum and cerebellum, and constitutes the great mass of the bodies situated in the interior of the cerebrum. Upon the surface of the cerebellum it forms a single tolerably thick lamina, arranged in transversely concentric plaits or folds of various sizes, which inclose the medullary matter of the organ. The internal surface of this layer is therefore in contact with the white matter, many of whose fibres penetrate nearly to its external surface.

Upon the surface of the cerebrum, the gray substance (which to the naked eye seems to form but one continuous layer, varying from two to three lines in thickness) is divided into two and sometimes into three layers by very thin membranous laminæ of medullary or white substance, whose fibres cross each other in every direction, and seem to be intended to associate or connect the remote parts of each stratum of gray substance (Fig. 20). The relative position of these alternate layers is as follows: 1. Upon the external surface is a delicate layer of white substance. 2. A tolerably thick deposit of gray substance. 3. Another thin white stratum. 4. A gray layer that is in contact with the central white substance of the organ. In some places, instead of four, six of these layers may be distinguished. The cells of the gray substance are small, generally spherical, and seldom caudate. They are imbedded in a matrix of granular matter, inclosed between the preceding white laminæ, and surrounded by tubular fibres that penetrate from the inclosed white substance of the brain nearly through the entire gray layer.

Fig. 20.

A view of the six alternating laminæ of a cerebral convolution, together with the straight white fibres of the medullary substance by which they are penetrated. In this drawing the exterior layer is represented of the cineritious order.

The deposits of gray matter (called the primitive ganglia) within the cerebrum are composed of large nerve-cells, surrounded by a granular matter and by tubular fibres, which come for the most part from the spinal cord.

The white substance of the encephalon is composed of tubular fibres, of somewhat smaller size than those of the spinal cord. These fibres are divided into two classes, according to their supposed functions; the one comprises all those that simply pass from one part of the brain to another, and are called converging or

commissural fibres; the other consists of those that come up, as it were, from the spinal cord, and diverge toward the under surface of the gray covering. These are named the divergent fibres, and are continuous below with the spinal nerves.

GANGLIA.—The centres of the sympathetic system of nerves, called the ganglia, are a series of small, fleshy-looking bodies, joined together by gray nerves, and situated upon the sides and in front of the vertebral column. But there are also ganglia connected with the cerebro-spinal nerves. Each one of the posterior roots of the true spinal nerves passes through, or rather forms a ganglion before it unites with its corresponding anterior root. They are also found upon the facial, glosso-pharyngeal, pneumogastric, and trigeminal nerves.

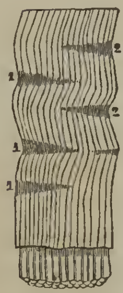
The ganglia of the sympathetic nerves are variable in size; the two largest, called the semilunar, are found in the abdomen, and are about the size and very nearly the shape of the common kidney-bean; the smallest can hardly be seen with the naked eye. Their elementary parts are; 1. A dense areolar investment continuous with the sheaths of the nerves; 2. Nerve-cells; and 3. Nerve-fibres. Upon making a section of one of these ganglia, it will be found divided into several compartments by processes from the areolar capsule, and by the nerve-fibres which are spread out in passing through. In these compartments is a reddish-gray matter (ganglionic substance), which, under the microscope, is seen to consist of oval-shaped nerve-cells, surrounded by granular corpuscles and gray fibres; a few of the cells are caudate, and it is possible, as has been suggested, that their filamentous prolongations are continuous with, or actually constitute the gray or pale fibres. The tubular fibres either pass directly through the ganglia (straight fibres), or ramify in a circuitous way in the gray substance, and then emerge (circumflex fibres).

THE NERVES.—The peripheral portion of the nervous system consists of nerve-fibres, which are collected into bundles, bound together by cellular tissue, and inclosed in a common sheath of the same material.

The cerebro-spinal nerves are composed principally of tubular fibres, varying in number according to the size of the cord. In nerves of large size these fibres are bound together in small bundles, or funiculi, which are surrounded by a sheath of areolar tissue denominated the *neurilemma;* and collected into larger bundles, or

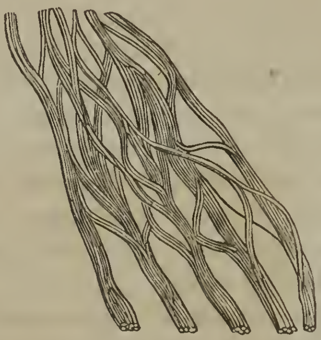
fascicles, recognizable by the naked eye, and also provided with a common areolar investment; and, lastly, these fascicles are ar-

Fig. 21.



Nerve with its neurilemma, magnified 50 diameters. 1, 2. Neurilemma. 3. Elementary nerve-fibrils. (From Mandl.)

Fig. 22.



The axillary plexus of nerves.

ranged into cords or nerves, and inclosed in a common sheath of dense cellular tissue.

In analyzing a nerve, therefore, we find it to consist of a strong areolar investment, from whose inner surface numerous processes are sent inward so as to mark off large cylindrical compartments, which are still farther subdivided; and, in these tubular compartments are situated, respectively, large and small bundles, called funiculi, which are divisible into elementary fibres.

The branching of nerves, which takes place throughout every part of the body, is produced by the separation of bundles and fibres, but never by the division of a primitive fibre, except possibly at their terminations. Again, nerves communicate with each other by an interchange of bundles and of fibres, but never by a blending of one fibre with another. These interchanges are, in some places, so numerous and complicated as to form a kind of network, or *plexus* (Fig. 22).

Origins of Nerves.—The internal or central extremities of the nerves are termed their roots and origins, in distinction from their peripheral extremities, which are called terminations. These origins are said to be apparent and actual. Thus, the spinal nerves have an *apparent* origin from the sides of the spinal cord; but their *actual* origin, which can be ascertained only by tracing out the minute fibres, is some distance off. In fact, little or nothing is posi-

tively known concerning the actual origins of the nerves. For farther information the student is referred to the article on the Spinal Cord.

The *terminations of nerves* are involved in almost as much doubt as their origins. It was once the prevailing opinion that the nerves have no terminations properly so called, but that the elementary fibres form loops with one another, and return to the centres,

Fig. 23.

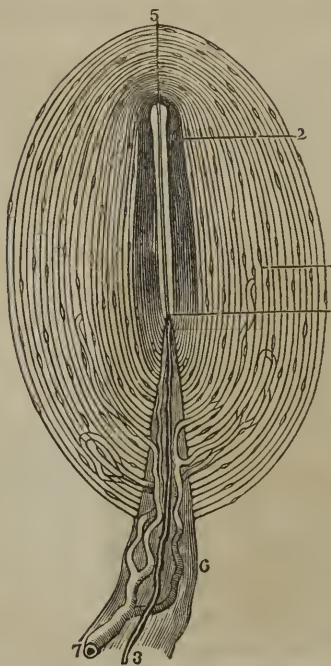
Ultimate anastomosis of a digital nerve. (Gerber.)

Fig. 24.

Pacinian bodies attached to a digital nerve. (Todd and Bowman.)

and this is undoubtedly the case in some parts of the body (see Fig. 23). Wagner supposes, however, that true terminations do occur; and this has been demonstrated in the nerves of the hand, whose fibres may be traced into little oval-shaped particles, called the *Pacinian bodies*, after Pacini, of Pisa, who first described them, about a century ago. These little organs (Fig. 24) are found in great numbers in the palms of the hands and soles of the feet, connected more particularly with the cutaneous branches of the nerves. They have been discovered also in other parts of the body, but in comparatively small numbers. Their size varies from $\frac{1}{15}$ to $\frac{1}{10}$ of an inch in length, and from $\frac{1}{25}$ to $\frac{1}{20}$ in breadth. They have a white or opaline appearance; and, when divided and examined under the microscope, are found to be composed of numerous concentric laminæ (Fig. 25), one within another, inclosing at the centre a small cylindrical cavity filled with a transparent fluid. The nerve-fibre enters this cavity at one extremity of the body, but the manner in which it is ultimately disposed of is not known.

Fig. 25.



Structure of the Pacinian body. 1. The external laminæ, which are kept separated and distended by a fluid. 2. The inner series of laminæ lying in contact. 3. The nerve, which at 4 has penetrated all the laminæ, and from that point to 5, where it terminates, is an attenuated white cord. 6. The conical stalk, or pedicle, deriving its external tunic from the neurilemma. 7. A capillary artery, that enters the corpuscle and ramifies upon its laminæ.

The *organic* or *ganglionic nerves* consist of both tubular and gray fibres, collected into fascicles, and inclosed within a common sheath. The proportion of the two kinds of fibres varies, but in most nerves the gray predominate. The tubular fibres are said not to present the ordinary double contour; they are of various sizes, a few being as large as $\frac{1}{1500}$ of an inch in diameter, and others again measuring only $\frac{1}{8000}$. The pale or gray fibres do not differ from those already described.

The tubular fibres of the ganglionic nerves may be readily traced to the anterior and posterior roots of the spinal nerves, and it is through this communication that the cerebro-spinal axis exerts the little influence it has over the organs supplied with nervous power from the sympathetic or organic system. It is also in consideration of this fact that modern physiologists incline to the opinion that the

Fig. 26.

Roots of a dorsal spinal nerve, and its union with the sympathetic. *c, c.* Anterior fissure of the spinal cord. *a.* Anterior root. *p.* Posterior root, with its ganglion. *a'.* Anterior branch. *p'.* Posterior branch. *s.* Sympathetic. *e.* Its double junction with the anterior branch of the spinal nerve by a white and a gray filament.

sympathetic system is only an appendage, as it were, to the cerebro-spinal.

EPITHELIAL TISSUE.

All the free surfaces of the body, both external and internal, are invested by a delicate transparent, cellulo-membranous layer, which upon the skin is denominated *epidermis*, or *cuticle*, and, upon the serous and mucous membranes, *epithelium*. In the former situation, it forms a thick horny coat for the protection of the cutaneous tissue, but it may be readily separated by blistering, which causes a collection of water beneath it, and thus detaches its connections. In the latter, it cannot be clearly demonstrated without the microscope. It consists essentially of nucleated cells held together by a tenacious blastema, and is doubtless produced by a constant process

of exudation from the surface upon which it is situated. It differs very greatly in thickness in different situations; the cells forming in some places several superimposed layers, and in others only a single thin pellicle. It is organized, although possessing neither vessels nor nerves; is rapidly reproduced when destroyed; and is, probably, always desquamating or wearing away at its free surface.

The difference in the shape, size, and disposition of the cells in different situations, has given rise to their division into several varieties, all of which may be comprised under three principal heads: 1. Tessellate epithelium; 2. Columnar epithelium; 3. Ciliate epithelium, to which a fourth is sometimes added, called the *spheroidal.*

Tessellate, pavement, or scaly epithelium (Fig. 27), examined upon its free surface, consists of angular, flattened cells, connected together by a tough, intercellular matter, and presents somewhat the appearance of blocks in a mosaic pavement. In some situations, as upon the serous membranes and the inner surface of the heart

Fig. 27.

Tessellate, pavement, or squamous epithelium. (Henle.)

Fig. 28.

Oblique section of the epidermis, showing the changes which the cells undergo in their progress from the true skin to the free surface. 1. Primitive cell. 2, 3, 6. Secondary cells in different phases. 4. Secondary cells flattened into a laminated structure. 5. True skin.

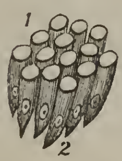
and bloodvessels, they form but a single delicate layer or film; but, upon the synovial membranes, the conjunctiva of the eye and some other mucous membranes, and more particularly upon the skin when it constitutes the cuticle or epidermis, it can be readily shown to consist of several strata (Fig. 28). In this stratified variety, the cells present different appearances at different depths, owing to certain changes which they undergo as they proceed toward the surface. If a vertical section of cuticle, taken from the palm of the

hand or sole of the foot, is examined with a lens, the cells lying next the true skin will be seen to be globular, distinctly nucleated, and imbedded in a clear, transparent, granular blastema; a little farther removed, they are still spherical but somewhat larger, and seem to be filled with a semifluid matter surrounding the nucleus, and the blastema appears of a more tenacious, viscid consistence. Still nearer the surface they are spread out or flattened, have a dry opaque appearance, and are much more firmly adherent to each other. Immediately along the line of the free surface, they present the appearance of a confused mass of undefined dry scales of a dull white color. In this last condition, they are continually falling off, to be replaced by others as they are pushed, as it were, outward by new ones constantly produced by the surface upon which the epithelium rests.

Besides the structures mentioned above as being covered by this variety of epithelium, the following also possess a coating of the same: the mucous membrane of the tympanum, and of the petrous cavities; the internal surface of the mouth, as far back as the commencement of the œsophagus; the stomach; seminal vesicles; pelvis of the kidney; female organs of generation, as high up as the middle of the neck of the uterus; the internal surface of the sclerotic coat and cornea; the outer surface of the choroid coat of the eye; the smallest divisions of the hepatic, salivary, and renal ducts; the lips; margins of the eyelids, and anus.

Columnar or *cylinder epithelium* (Fig. 29) differs from the preceding in being made up of cells vertically elongated, and arranged side by side in an upright position. The shape of the cells is not precisely the same in all situations; they are, however, generally

Fig. 29.



Columnar epithelial cells viewed obliquely. 1. Free ends. 2. Attached extremities inclosing nucleated nuclei. (Todd and Bowman.)

flattened on two opposite sides, and broader at their free than at their attached extremities, where, indeed, they are often pediculated. In some places they are regularly cylindrical, and sometimes fusiform or even bell-shaped. They all have large oval

nuclei* in their centres, and, in their large extremities, a quantity of clear granular-looking matter. An intervening substance or blastema fills up the interstices between their small or attached extremities, and binds them together.

The columnar epithelium occurs only upon mucous surfaces; it is found at the cardiac orifice of the stomach, throughout the whole length of the intestines, in the urethra, in the main trunks and larger branches of the various ducts that open into the alimentary canal, in the gall-bladder, and probably also in the urinary bladder. It is still undetermined whether this variety of epithelial tissue is subject to desquamation or wearing away at its free surface, and supposing this to be the fact, the mode of its reproduction is also unknown. Gerber says that the cells rest upon a layer of tessellated epithelium, whose cells become columnar. Others suppose that the whole layer is cast off at once, and that the parts beneath are temporarily denuded.

Ciliated epithelium (Fig. 30), consists of cells that are provided with little hair-like processes called ciliæ. The cells, generally

Fig. 30.

Vibratile or ciliate epithelium. 1. Nucleated cells, resting on their smaller ends. 2. Cilia. (From Henlé.)

columnar, are sometimes tessellate, and hence the distinction into tessellate and columnar ciliate epithelia. The nasal cavities, frontal and maxillary sinuses, lachrymal sac and ducts, posterior surfaces of the soft palate and fauces, the Eustachian tube, larynx, trachea, bronchia, uterus, and Fallopian tubes, are all furnished with columnar epithelium. The tessellate variety exists upon the internal surface of the cerebral cavities, and possibly in the tubular fibres of the nerves.

The ciliæ are situated upon the free surface of the epithelium, like the pile on velvet, and are therefore attached to the corresponding parts of the cells. In order to be seen to advantage, a vertical section of the tissue must be made and examined laterally or obliquely. If the tissue is fresh, they exhibit a most beautiful waving

* Henlé denies the existence of nuclei in the columnar cells of the gall-bladder.

to and fro, like a field of young wheat; and, if a little fine powder is sprinkled upon the surface, the particles may be observed to be carried or floated along in the direction of the waving, and finally thrown off at the cut margin.

The shape and size of the ciliæ differ in different individuals; generally, however, they are filiform or slightly conical with two sides flattened. They vary in length from $\frac{1}{4000}$ to $\frac{1}{2500}$ of an inch. Although their position is for the most part nearly vertical, a close examination will prove them to be a little inclined toward the natural outlets of the cavities which they line. This arrangement is connected with their function of impelling or carrying off the fluids with which they are in contact.

The existence of this ciliary motion readily explains the passage of fluids along cavities, such as the salivary ducts, whose walls possess no contractile property. The source or nature of this power is as yet involved in obscurity. Sharpey supposes it to result from inherent contractility; others from a species of erection which these little organs undergo, and others still, to the contraction of muscular fibres attached to the base of each. The shedding of the ciliæ is yet an undecided question.

PIGMENTARY TISSUE.

The black color of the choroid coat of the eye, and the skin of the negro, and the various shades of brown presented by the other races of mankind, are due to a peculiar coloring matter called *black pigment*, which is contained in cells or vesicles, whose sizes vary in different individuals and in different situations. In the choroid coat of the eye, the cells are quite large, polyhedral in shape, and arranged somewhat like the tessellate epithelial cells. They consist of a delicate homogeneous membrane, inclosing a transparent nucleus, which is surrounded by the minute granules of the coloring matter. This is insoluble in cold and hot water, alcohol, ether, and the volatile oils. On analysis, it yields carbon, hydrogen, nitrogen, and oxygen, and a small quantity of oxide of iron, common salt, and phosphate of lime.

Fig. 31.

Black pigment-cells, magnified 410 diameters. *a*, *b*. Nuclei.

The pigment-cells of the skin of the negro are much smaller than

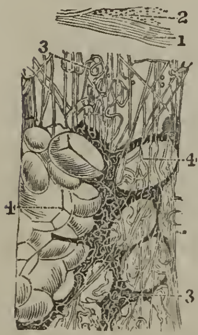
those of the choroid membrane, and are situated in the deep layer of the epidermis, where they are intermixed with the epithelial cells. In the skin of the lighter-colored races, the cells are still smaller and very much scattered. It is probable that they do not exist here as true cells, but that the granules of black pigment are scattered throughout the deep portions of the epidermis, without any inclosing membrane.

ADIPOSE TISSUE.

Adipose tissue is the fat of animals. It consists of small membranous cells containing the peculiar fatty matter, which are aggregated in little irregular lobules, and sometimes in considerable masses.

The adipose cells or vesicles are round or oval in the living animal, but after death, when the contained matter is solidified, they are generally polyhedral. Their diameter varies from $\frac{1}{300}$ to $\frac{1}{600}$ of an inch. By transmitted light, they present a clear opaline tint exteriorly, and a cloudy white appearance within. They are always surrounded by areolar tissue, which binds them to each other and the surrounding structures, and thus prevents their gravitating toward the dependent parts of the body.

Fig. 32.



Fat-cells lodged in areolar tissue. 1. Fasciculus of areolar tissue. 2. Same in a more amorphous state. 3, 3. White and yellow fibres of areolar tissue. 4, 4. Adipose cells or vesicles.

The quantity of adipose tissue in the human body, although subject to great variation, is generally in proportion to the degree of nutrition. It is distributed with some uniformity throughout the system, but is much more constant in some situations than in others. In the subcutaneous areolar tissue of the abdomen, pubis, buttocks, face, and armpits, in the orbits, upon the heart, and in the cellular tissue around the kidneys and the spinal cord, it is always present except in cases of extreme emaciation. In the eyelids, prepuce, scrotum, cavity of the cranium, on the surface of the lungs, and the glandular organs generally, it never occurs, however great its general development.

During life, the substance of the fat-cells is in a semiliquid state,

but it congeals and solidifies after death. It is inodorous, of a pale yellowish color, a faint sweetish taste, and soon becomes rancid and disagreeable when exposed to the air. Chemically examined, it is at first resolved into a solid substance called margarin, and a fluid denominated olein.

The adipose tissue is freely supplied with bloodvessels, which ramify between the little lobules, sending to each a twig that subdivides to each of the cells. No lymphatics or nerves have ever been traced into the cells, but they are often seen to pass between them on their way to other parts.

The uses of the adipose tissue are various. Beneath the skin, it assists in retaining the heat of the body; it surrounds and facilitates the motion of the joints; by filling out the inter-muscular spaces of the face and neck, it gives to the features the rounded lines of beauty; its presence in the centres of the bones increases their solidity and elasticity; and lastly, wherever situated, it serves as nutriment in reserve, to be taken up and used by the system, when, from disease or other causes, the usual food is withheld.

MUSCULAR TISSUE.

The muscles, constituting what is commonly termed the flesh of animals, are the instruments by which the active movements of the body are effected. For this purpose they are endowed with a special vital property termed *contractility*, or *irritability*. In many of the muscles, those, for instance, of locomotion, respiration, and the movements of the organs of sense, this property is to a certain extent under the control of the will, and they are denominated on that account voluntary muscles; on the other hand, the heart, the muscular coat of the stomach and intestines, and some others are entirely beyond this influence, and are called therefore involuntary muscles.

Voluntary Muscles.—The voluntary muscles, or, as they are frequently called, "the muscles of animal life," are separate and distinct organs, all composed, however, of the same elementary parts. Their bright red appearance, fibrous texture, and variety of shape and size are familiar to every one. Their number in the

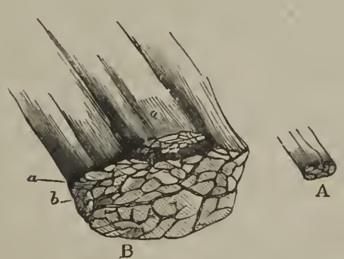
* The fat of some animals contains an additional substance called stearin.

human body is variously stated from three to four hundred. With one exception, they all exist in pairs, and usually have at least one attachment to the skeleton. In the extremities, they are generally elongated in a common direction, and are provided with rounded tendons, by which they are attached to the bones. On the trunk, they are mostly spread out, as it were, into broad layers with numerous attachments, and have tendons of the same membranous form. Chemically, they consist of water and fibrin, with a small quantity of albumen, coloring matter, and various salts.

Structure.—The muscular tissue of animal life presents to the naked eye a collection of well defined, red, fibrous threads, arranged side by side in each particular muscle, and varying in size and shape in different parts of the system. Examined with a microscope, these threads are found to be bundles of smaller threads, or fibres, which, under an instrument of high power, are resolved into fibrillæ, or primitive fibres. Each muscle is, therefore, made up of fibrillæ, forming fibres which are collected into bundles, or fasciculi, visible to the unassisted eye. The means of union between these different parts is ordinary areolar tissue, which forms also a common investment or sheath for the whole.

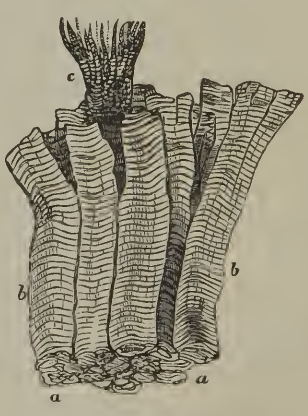
The *fasciculi* (Fig 33) have generally an angular outline; and according to the number of fibres they contain give to the different muscles a corresponding appearance of a coarse or fine texture. They are each provided with a separate envelop of areolar tissue,

Fig. 33.



A. A small portion of muscle, natural size. B. The same, magnified 5 diameters, of larger and smaller fasciculi, seen in a transverse section.

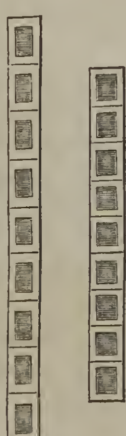
Fig. 34.



A few muscular fibres, being part of a small fasciculus, highly magnified, showing the transverse striæ. *a*. End view of *b b*, fibres. c. A fibre split into its fibrillæ.

prolonged inwardly from the common sheath of the muscle, which binds them closely together, and serves also in some degree as a means of isolation. The *fibres* (Fig 34), also somewhat angular in shape, measure about $\frac{1}{400}$ of an inch in diameter; they are somewhat smaller in muscles of a fine than in those of a coarse texture, and in the muscles of the female than in those of the male.* They have each a translucent, homogeneous envelop, called the sarcolemma, which may be readily demonstrated in the larger fibres of some of the inferior animals, and is said to be entirely distinct from the areolar tissue that envelops the fasciculi. They are also characterized by certain transverse linear markings called striæ, which are due to the peculiar structure and arrangement of the fibrillæ. These transverse lines or striæ exist upon the fibres of all the voluntary muscles, upon some, as the diaphragm, that are not strictly voluntary, and also upon those of the heart. The *fibrillæ* (Fig. 34, *c*), or primitive fibres, are about $\frac{1}{15000}$ of an inch in diameter, and seem to be composed of very minute, dark-looking quadrangular or polygonal particles (Fig. 35), disposed in longitudi-

Fig. 35.



Ultimate fibrilla of muscle. (Carpenter.)

Fig. 36.

A muscular fibre, showing the separation into disks. (From Dr. Skey.)

nal series, or rows. This arrangement produces a beaded appearance peculiar to this variety of muscular tissue. It is the lateral correspondence and union between the particles of all the fibrillæ in each

* Bowman.

fibre, that gives to the latter its characteristic striped appearance, and which causes it sometimes to split into transverse plates or disks, as represented in Fig. 36.

The muscles are largely supplied with arteries, veins, and nerves. The *arteries* and *veins* enter between the fasciculi, and penetrating their sheaths, form capillary plexuses around the individual fibres. They have never been traced into the sarcolemma. The *nerves* belong principally to the motor division of the cerebro-spinal system. They accompany the arteries and ramify with them between the fibres, but their ultimate termination is not known. It was for a long time supposed that the smallest nervous filaments, after penetrating the fasciculi, crossed the fibres obliquely or transversely at certain distances apart, and then, forming loops, returned upon themselves (Fig. 37); more recent observations have failed to confirm this opinion.

Fig. 37.

Loop-like termination of nervous filaments in muscle. (Mandl.)

The reunion between muscles and their tendons takes place solely by means of the constituent areolar tissue of the former. The sheaths of the fasciculi and fibres becomes condensed, and their structure gradually merges into that of tendinous fibre.

Involuntary Muscle.—The muscular tissue of organic life performs those movements of the body that are entirely beyond the control of the will. It is abundant, therefore, in the walls of the œsophagus, stomach, small and large intestines, the bladder and pregnant uterus, and in smaller quantities in the trachea, bronchial tubes, ureters, hepatic and pancreatic ducts, seminal vesicles, deferential tube, and the middle coat of the bloodvessels and lymphatics. It is readily distinguished from the animal variety by its pale, dirty-grayish color, its want of any attachment to the skeleton, the scattered irregular arrangement of its fibres, and the entire absence of any tendinous connections. Its ultimate fibres (Fig. 38) are larger than the fibrillæ of voluntary muscles, measuring from $\frac{1}{2000}$ to $\frac{1}{3000}$ of an inch in diameter. They are generally devoid of transverse

markings, and appear obscurely translucent at the centre, with a dark shaded border on each side. At numerous points, they present oblong nuclei, which are the remains of original cells, and often give them a knotted or clubbed appearance.

Fig. 38.

Fibres of involuntary or organic muscle.

The fibres of the heart form an exception to this description. They present the bright red color, the fascicular arrangement, and the transverse striæ of voluntary muscle. These striæ are, however, by no means distinct, and the fibres themselves are somewhat smaller than those of the animal variety. Fibres like those of the heart are said to exist also in the œsophagus within an inch of the stomach, in the iris, and in the muscles of the ear, in which situations they are mixed with the muscular fibres of organic life.

Chemical Composition of Muscle.—Analyzed with a view to its immediate constituents, muscular tissue is found to consist principally of water and fibrin. The relative proportions of these two, as well as of the other constituents in the voluntary muscle of the ox, as analyzed by Berzelius, is as follows :—

Fibrin	15.8
Gelatin	1.9
Albumen with coloring matter	2.2
Alcoholic extractive with salts	1.8
Watery extractive with salts	1.05
Phosphate of lime with albumen	0.08
Water and loss	77.17
	100.00

FIBROUS TISSUE.

The fibrous tissue is found in great abundance in different parts of the body, subserving a variety of purposes, nearly all of which are entirely mechanical. It is characterized by a brilliant white or pearly color, great strength, perfect pliability, an almost entire want of elasticity or extensibility, and a very low grade of vitality. Examined closely with the naked eye, it is seen to consist of small

Fig. 39.

Elementary fibres of tendon seen under the microscope.

shining threads, or fibres, which in some situations are parallel, and sometimes cross each other in every direction. Analyzed with the microscope, these so-called fibres are found to be bundles of still smaller filaments, which bear a very close resemblance to those of areolar tissue. Indeed, these two tissues constitute properly but one system, and are distinguished only by differences in the closeness of the arrangement of their ultimate fibres. Hence, the discrepancies among anatomists in regard to the classification of certain structures, that belong to one or other of these divisions; what is denominated areolar or cellular by some, is called fibrous by others, and conversely.

The forms of the different fibrous structures, and the names by which they are known, vary in different situations. Around the joints, where this tissue binds the opposed bones together, the fibres are parallel and are collected into funiculi, or cords, called ligaments; upon the muscles of the extremities, it is spread out into membranes denominated fasciæ, or aponeuroses; at the ends of the muscles, it is the medium of attachment between them and the bones, and is called tendon, which may be either cord-like or membranous. It forms also a closely investing membrane for the bones, called periosteum, and lastly membranous coverings for several of the organs, *e. g.* the dura mater, the proper tunic of the testis, &c. In consequence of the low vitality of this tissue, when it is attacked with acute inflammation, it soon passes into a state of mortification. When punctured, cut, or subjected to the action of chemical irritants in the living animal, no evidences of sensibility are observed, but when violently twisted or stretched, as in severe sprains, the most acute pain is often experienced. Whether this pain is produced by the injury to the ligaments themselves, or to that of contiguous nerves, is an undetermined question.

By long boiling, fibrous, like areolar tissue, is almost wholly converted into gelatin. The proper bloodvessels of fibrous tissue can be seen only with a magnifying-glass; they are very small and much scattered, except in the periosteum and dura mater, in which there are large arteries and veins; but in these cases the vessels simply traverse the tissue in order to reach other parts. In consequence of this difference in vascularity, the fibrous tissues are considered

by Prof. Palmer* as divisible into two classes, the vascular and non-vascular. The former he calls fibro-vascular, including under this head the periosteum, pia-mater, capsule of Glisson, &c. This distinction is highly useful, since the two differ very widely in their functions. The fibro-vascular tissue forms nutrient membranes for the structures which it incloses, but the non-vascular is entirely mechanical in its use.

YELLOW ELASTIC TISSUE.

The yellow elastic tissue is analogous to the preceding, but differs from it in several important particulars, the most remarkable of which are its great extensibility and elasticity. It is employed in the animal economy, when continued or frequently intermitting support or resistance is required, and, in many situations, it serves at the same time as ligaments, and sometimes as envelops to certain organs. It is largely developed in the back of the neck of quadrupeds, where it is called the nucha ligament (ligamentum nuchæ), or, by the common people, whit-leather. In the human subject, it is found as a separate tissue, principally between the arches of the vertebræ, and in the trachea, bronchial tubes, bloodvessels, and scrotum. In other situations, it is largely mixed with areolar tissue, as in the true skin, beneath the serous membranes, and in the external coats of the arteries and veins.

Fig. 40.

Yellow fibrous tissue. (Mandl.)

To the naked eye, the yellow elastic tissue presents the appearance of longitudinal, parallel fasciculi, of a dull-yellowish color, and a rather rough or flocculent surface. Under the microscope, these fasciculi are resolved into well-defined transparent fibres (Fig. 40), which, traced out, are found to have a serpentine course, and soon divide into branches, that form a kind of network between the larger trunks. They have also been noticed to possess a peculiar tendency to curl up at the blunt ends. Their size varies greatly, some of the larger trunks measuring as much as $\frac{1}{4000}$ of an inch, while many of the smaller branches do not exceed $\frac{1}{22000}$.

Yellow elastic tissue long resists the action of boiling water, but,

* Professor of Anatomy in the University of Louisville.

like fibrous and areolar tissue, is ultimately converted into gelatin. The acids and alkalies have little or no effect upon it. In alcohol, it retains its extensibility and elasticity for an unlimited time. No nerves have ever been traced into this structure, and, as far as we know, it possesses no sensibility whatever. Its fibres are not endowed with vital contractility, but they frequently exist in conjunction with true involuntary muscular fibres, as in the middle coat of the arteries. Its bloodvessels are few, small, and scattered, as in the fibrous tissue.

CARTILAGINOUS TISSUE.

Cartilaginous tissue enters largely into the composition of the body, especially in its growing state, and, like the non-vascular fibrous tissue, is almost entirely mechanical in its uses. Two varieties are generally distinguished, the *temporary* and *permanent*. In the former, the osseous matter is deposited to form bone; the latter remains unchanged through life. The simple term cartilage, is usually applied to the latter kind, and is itself divided into *true* and *fibro-cartilage*. Their differences will be hereafter mentioned.

Cartilage does not possess precisely the same properties in all parts of the body. It is generally a very dense elastic substance, of an opaque white color, variously tinged with blue, grating under the knife, and, when fresh cut, presents the appearance of an amorphous, hyaline matter, in a state of great condensation. Exposed to the weather it resists putrefaction for a long time. On exposure to heat it loses about three-fifths of its weight by the evaporation of its watery parts, becomes hard and crisp, much diminished in volume, semitransparent, and of a yellowish-brown color. By boiling for twelve or eighteen hours, it is converted into a clear, jelly-like substance called *chondrin*, which, unlike ordinary gelatin, is soluble in alcohol, and is precipitated from its solutions by alum, acetic acid, acetate of lead, and sulphate of iron.

According to its distribution cartilage is divided into two varieties, the *articular* and the *non-articular*, names which sufficiently indicate the basis of the division.

The articular cartilage exists in the form of solid masses or plates, which, including those situated between the extremities of the ribs and the sternum, are of three kinds: 1. The articular car-

tilages, properly so called, namely, those that form a covering to the extremities of the opposed bones in the movable joints; 2. Those that connect the opposed bones in the immovable articulations, as, for instance, the intervertebral disks; 3. The inter-articular cartilages, consisting of detached plates situated between the opposed surfaces in some of the movable articulations.

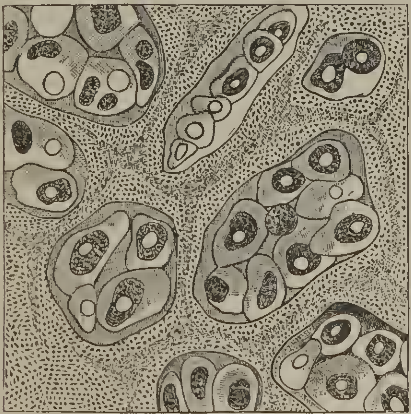
The non-articular cartilages form the framework or skeleton of certain organs. Such are the cartilages of the ear, nose, larynx, trachea, eyelids, &c. Their office is to give shape, support, and protection to the several parts. Unlike the articular cartilages, they are all closely invested by a strong fibrous membrane, like that which surrounds the bones, called the *perichondrium.*

To the naked eye, some of the cartilages appear to consist wholly of a homogeneous, glassy-looking amorphous substance, and others appear to be intermixed with fibres in greater or less abundance. It is this difference that has given rise to the division into *true* and *fibro*-cartilage. The distinction cannot, however, be always preserved, on account of the gradual transition of the one into the other in different situations.

Structure.—By the microscope, cartilage is found to be composed of nucleated cells, deposited in an intermediate substance or matrix, which is either homogeneous or fibrous.

The *cartilage cells* or *corpuscles* in matured true cartilage, present the appearance of minute cavities in the surrounding substance, filled with a clear, colorless, consistent fluid; but in fibro-cartilage,

Fig. 41.



A transverse section of a cartilage of a rib magnified 350 diameters, showing the parent cartilage cells in groups. (Hassal.)

they can be readily displaced without injury, and are then found to possess a distinct cell-wall, an inclosed fluid, and a nucleus. Their shape, size, and disposition are not similar in all situations, but, as a general rule, they have an irregular outline, and are arranged into groups (Fig. 41), varying in the different varieties of the tissue. These groups or patches are generally flattened, and disposed in close layers near the free surface of the cartilages (Fig. 42), but

Fig. 42.

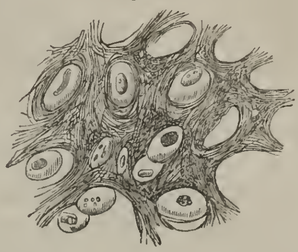
A transverse section of a cartilage of a rib magnified 350 diameters, showing the perichondrium and the comprised cells next to margin of the cartilage. The fibrous structure of the perichondrium is also exhibited.

they have no particular form or arrangement in the deeper parts. In a vertical section, they present therefore a transverse, linear appearance near the free edge, but, more deeply, that of an irregularly pitted surface. In the cartilages of the movable joints, it is said, however, that they are arranged in rows parallel with each other, and perpendicular to the surface of the bone. To this arrangement may be due the fibrous appearance of a vertical section of this particular species of cartilage.

The *matrix*, or intercellular substance (Fig. 41), in some instances, as in the articular cartilages, presents the appearance of a transparent, homogeneous, finely granulated matter, surrounding the cells and constituting the greater bulk of the tissue. In other cases, this matrix is more or less intermixed with fibres, which are usually short, and sometimes parallel, but more frequently winding between the cells, and crossing each other in various directions. The

quantity of these fibres varies in different situations, according to the particular requirements of the part or organ. Where they are very numerous, as in the intervertebral plates, the cartilages of the ear and nose, the epiglottis, Eustachian tube, &c., the tissue has a yellowish opaque appearance, and is remarkable for its tough texture, its flexibility, and its great elasticity.

Fig. 43.



Section of the epiglottis, showing the cartilage cells and intro-cellular fibrous matrix. (Baly.)

Cartilaginous tissue generally is entirely destitute of *bloodvessels*, the only exception being the costal cartilages, in which a few scattered twigs are found ramifying through the parts too deep to be supplied with nourishment from the vessels of the perichondrium. No *nerves* have ever been traced into this tissue, so that it is entirely devoid of sensibility.

In old age, the fibro-cartilages become firm and unyielding to a degree that renders the movements of some parts difficult, and of others impossible. The cartilages of the ribs and trachea are frequently transformed into bone. When once destroyed, cartilage is never reproduced. This is said to be owing to the mode in which it receives its nourishment, which is by diosmosis, as might be inferred from the statement that it contains no bloodvessels. When fractured, an accident that sometimes happens to the costal cartilages, reunion takes place by the deposit of a fibrous substance, furnished by the vessels of the perichondrium. Sometimes, instead of this fibrous matter, a bony clasp surrounds the broken extremities.

OSSEOUS TISSUE.

The osseous system consists of a large number of separate pieces called *bones*, which united constitute the *skeleton* or framework of the body.

The bones are distinguished from all other organs by their almost stony hardness, yellowish-white color, the slight degree to which they can be flexed and extended, and their entire want of sensibility. They form a basis of support for all the soft parts, shielding many that are delicately organized, and serve as levers by which the muscles perform the various movements of the body.

6

In reference to their form, the bones are divided into three classes—the *long*, the *broad*, and the *short;* to which a fourth is sometimes added called the *mixed*, or by Quain, the *complex* bones.

The *long* bones are situated for the most part in the extremities. Each of them has a shaft, or body, which is nearly always an irregular three-sided prism, and two expanded extremities that serve for the formation of joints, the attachment of ligaments, and the reflection of tendons. The length and breadth of the *broad* bones are nearly equal, and much greater than their thickness; they are intended principally for the formation of cavities, and are much less numerous than either of the other two varieties. The three dimensions of the *short* bones are nearly equal, but their contour is generally very irregular. They are found where great strength and slight motion are required; as in the spinal column, tarsus, and carpus. The *mixed* bones partake of the distinguishing characters of the three preceding classes, but most nearly resemble the last.

In studying the external characters of the bones, many points must be considered besides their general form. They present numerous prominences and depressions, ridges, fissures, &c; some of which may be briefly designated here.

Eminences.—The old anatomists classed all the bony prominences or processes under two heads, *apophyses* and *epiphyses*. The former comprised all those projections produced by a prolongation of the bone, and the latter all that were known to be developed separately, and afterwards united to the main portion, or body. These names, and the distinction which they characterized, are now, however, almost entirely disused.

The term apophysis, when employed at all, is now applied to any prominence or elevation of the bone, without reference to its formation. The word epiphysis is almost obsolete. Another and far better distinction, into articular and non-articular prominences, is the one generally adopted.

The *articular* eminences, so called because they are essential parts of articulations, or joints, are smooth and well defined, and, in the recent state, covered with cartilage. Their shape and size differ materially in different situations, but in the corresponding bones of different individuals, they are nearly alike. Their special names, when they have any, are usually derived from their outline. Thus, a spherical outline constitutes a head, which is called a condyle when flattened upon two opposite sides.

The *non-articular* processes, or eminences, are rough and irregu-

lar, and principally designed for the insertion of muscles. They are known by a variety of names. When large, uneven, and somewhat rounded, they are called tuberosities; when smaller, tubercles; when slender, sharp, and small, the name spinous process is applied; when elongated upon the surface of the bone, presenting an irregular free edge, they are denominated crests, or ridges, and sometimes lines. Some have received names from their fancied resemblance to certain objects: *e. g.* zygomatic (like a yoke), styloid (like a style), odontoid (like a tooth), &c.

Depressions.—The depressions or cavities of bones are intended, (1) for articulation, (2) for the insertion of muscles and ligaments, and (3) for the passage of vessels and nerves. Their shape and size, and the names by which they are known, are exceedingly various, and forbid any general classification. Thus, the excavation upon the innominate bone, for the articulation of the head of the femur, is deep and hemispherical, and is called the cotyloid* cavity; the sockets of the teeth are named alveoli,† &c. Many articular cavities are superficial, and to these the term glenoid is applied. Fossæ, are shallow excavations of various sizes; sinuses, are cavities with a narrow entrance; furrows, or grooves, are superficial excavations, whose names sufficiently indicate their form. Foramina, or perforations, may have smooth or irregular margins; in the latter case they are called lacerated foramina; when small and irregular, hiatuses; when long and narrow, canals.

Most of the foramina found upon the surface of the bones are intended for the transmission of bloodvessels. Three kinds are usually enumerated.

1. The external surface of every bone will be found on examination to be perforated by thousands of minute openings, leading into the substance of the organ. They all contain arteries and veins, particularly the former, which pass to and from the periosteum. They must not, however, be confounded with the little pits, which also exist in the same situation, and receive fibrous prolongations of the periosteum.

2. Each bone has what is called a nutritious foramen, through which its principal artery is transmitted. In the long bones, this foramen is situated in the shaft, generally nearer the superior than the inferior extremity. In the broad bones, it exists on one of the

* Like a cup. † Like the cells of a honey-comb.

flat surfaces, and in the short, it has no regular position. Some bones have two foramina of this kind.

3. The extremities of the long bones just beyond their articular surfaces, the adjacent parts of the circumference of the broad, and the bodies of the short bones present numerous large foramina, many of which are almost as large as the nutritious foramen. These are intended chiefly for the transmission of veins.

The osseous is by far the heaviest tissue in the body; but in the short bones and the extremities of the long ones, it incloses numerous large cells, or cavities, which render these parts comparatively light. In the shafts of the long bones, and the external *crust* of the short bones, these cells are small, and the tissue dense and hard.

Composition.—Without its investing membrane, and its contained water and fat, bone is found to consist of two distinct parts, the organic, or animal, and the inorganic, or earthy. To obtain these parts in a separate state two processes are necessary: 1. Weak hydrochloric acid easily dissolves out the earthy matters, and leaves a tough, elastic, flexible substance, in the shape of the original bone. This is the animal or organic part, or, as it is sometimes improperly called, the cartilage of the bone.

2. By long and careful burning the animal matter may be consumed, leaving the earthy part as an opaque white substance, which still possesses the form of the bone unimpaired, but crumbles to powder under the slightest pressure.

In the bones of the adult, the proportion of earthy to animal constituents is about two to one. In young subjects, the proportion of animal substance is greater, and in old persons less. The subjoined tables of the analyses by Berzelius and Marchand, show the exact proportion of the two, and the composition of the earthy substance, which will be seen to consist almost entirely of phosphate and carbonate of lime.

		Berzelius.	Marchand.
1. Organic or animal matter,		33.30	33.26
2. Inorganic or earthy constituent.	Phosphate of lime	51.04	52.26
	Carbonate of lime	11.30	10.21
	Fluoride of calcium	2.00	1.00
	Phosphate of magnesia	1.16	1.05
	Soda and chloride of sodium	1.20	1.17
	Oxide of iron and manganese and loss	1.00	1.05
		100.00	100.00

Structure.—Under an ordinary magnifying-glass, or even to the naked eye, the external surface of the bones presents the appearance of compactly arranged fibres, which are longitudinal and parallel in the shafts of the long bones; in the broad, they diverge from the centre toward the circumference; and in the extremities of the former and the bodies of the short they are disposed in an irregular manner. To demonstrate these fibres, it is only necessary to remove the earthy substance, when, by bruising the extremity of the remaining animal substance, or by means of a pin or needle, they may be separated from each other to a considerable extent. At the same time, it will be found that the fibres form superimposed lamellæ, or plates, which are connected by short bony filaments passing obliquely from one to another. This arrangement is also sometimes beautifully seen in bones that have been exposed to the weather; under these circumstances, there occurs an exfoliation or detachment of the layers successively from without inward. The number and disposition of the laminæ vary in the different classes of bones, and in different parts of the same bone. In the shafts of the long bones, they are numerous and concentric; while in the short and broad varieties, and in the extremities of the long bones, there is often but a single layer, which forms the external crust, or shell.

If a bone is carefully divided with a saw, the section will also present a fibrous appearance. In the shafts of the long bones and the crust of their extremities, and in the crust of the broad and short bones, these fibres seem to be close and compact, while in other situations (viz., in the interior of the broad and short and extremities of the long) they form a loose open texture, whose interstices or cells are often very large. Based upon this difference in density, two kinds of tissue have been recognized by anatomists, namely, the *compact*, and the *cellular*, or *spongy;* but, as correctly affirmed by Cruveilhier, there is properly but *one* form of structure, the *areolar*, or *cellular*, which presents itself in some situations in a dense, or compact, and in others, in an open spongy form. The two varieties insensibly blend into each other. Cells, therefore, exist in all parts of the bones, and their size and shape depend upon the arrangement of the bony fibres and lamellæ. Whatever their size may be, they all communicate in the same bone, and, in the spongy tissue at least, are lined by a delicate vascular membrane that secretes the fatty matter with which, in the fresh bone, they are nearly always filled.

Such are the general characters of osseous tissue as seen with the

naked eye or through a simple lens. The microscopic characters are equally interesting, and require a brief notice.

Microscopic Appearances.—If a thin section of bone, a transverse one, for instance, of a long bone, is examined by transmitted light, with a magnifying power of from three to six or eight hundred diameters, several dark circular or oval spots will be seen, surrounded by numerous concentric lines; and, at short intervals upon the latter, minute black specks, with other lines leading off from them in different directions. The large spots are the cut extremities or sides of vessels, called, after their discoverer, the Haversian canals; the concentric lines indicate the delicate concentric laminæ of bone surrounding these canals; and the small specks are little cavities called lacunæ, situated between the laminæ, and communicating with each other by minute canaliculi, which are shown by the crooked lines.

The Haversian canals (Fig. 44) are very numerous, particularly

Fig. 44.

A. Transverse section of a bone (ulna) deprived of its earth by acid. The openings of the Haversian canals seen. Natural size. A small portion is shaded, to indicate the part magnified in Fig. B.

B. Part of the section A magnified 20 diameters. The lines indicating the concentric lamellæ are seen, and among them the corpuscles of lacunæ appear as little dark specks. The foramina are the cut extremities of the Haversian canals.

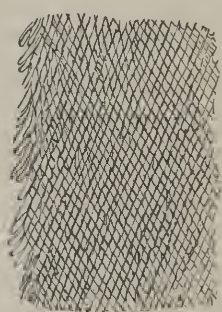
in the compact portion of bones, and they are remarkable for their short and tortuous course. Their diameter varies from $\frac{1}{200}$ to $\frac{1}{1000}$ of an inch. They communicate freely with each other, and, in the fresh state, are occupied by the small bloodvessels that ramify throughout every part of the tissue. The most superficial are generally very small, and open upon the surface by pores, through which the vessels from the periosteum are received. The deep-seated are larger, and, in the long bones, often communicate with the medullary canal,* probably for the purpose of transmitting vessels from the vascular membrane that surrounds the marrow.

The concentric laminæ (Fig. 45) surround the Haversian canals, and follow the same crooked course. This may be proved by

Fig. 45.

Haversian canal and concentric laminæ, seen upon a transverse section of a portion of the tibia, which has been macerated in dilute muriatic acid. The laminæ are brought distinctly into view, but the lacunæ, being filled with fluid, are not seen. (Mr. Tomes.)

Fig. 46.



Thin layer peeled off from a softened bone, as it appears under a magnifying power of 400 diameters. The figure, which is intended to represent the reticular structure of a lamella, gives a better idea of the object when held rather farther off than usual from the eye.

examining a longitudinal or oblique section of a canal, where it will be seen that the lines run parallel with it, in the former case, and in the latter, form ellipses around its extremity instead of circles, as when cut transversely. Their number around any one canal varies from one to six or eight, being generally greater in the compact than in the spongy tissue. They are exceedingly thin, and are said to consist of minute transparent fibres arranged in two sets,

* Quain.

the fibres of each set running parallel but crossing the others obliquely (Fig. 46).

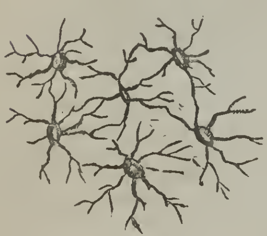
The lacunæ (Figs. 47, 48, and 49), or, as they are often improperly called, the bone corpuscles, are little recesses* in the bone, situated

Fig. 47.

Transverse section of the Haversian canal and lacunæ. (Lessing.)

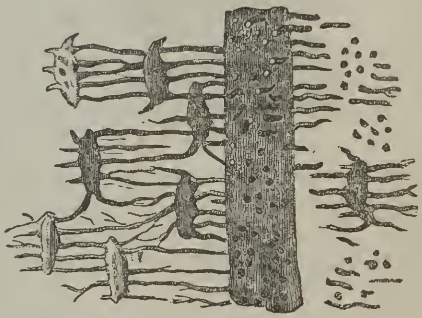
in great numbers between the laminæ, through which they communicate by means of their tubular prolongations (canaliculi). The shape of these lacunæ is that of an oval, flattened, as it were, between

Fig. 48.



Lacunæ or corpuscle of Purkinje, with their connecting tubuli or canaliculi. (Lessing.)

Fig. 49.



Haversian canal, lacunæ, and canaliculi. (Lessing.)

the laminæ; hence, when divided in any direction, they present the elongated fusiform outline represented in the figure.

* To prove that these lacunæ are really cavities, it is only necessary to place the section upon a dark background, and then drop upon it a little colored fluid of some sort, when the latter will be seen to enter the lacunæ and pass from one to another through the canaliculi.

The canaliculi pass off from the lacunæ in every direction, and, as just mentioned, form numerous anastomoses both between and through the laminæ; they thus maintain a free communication in every part of the bone. Since those nearest the Haversian canals open into them (Fig. 49), both lacunæ and canaliculi may be considered as appendages to the vascular canals, and are intended, in all probability, for the transmission of fluids to and from those portions of the tissue too minute to be reached by ordinary vessels.

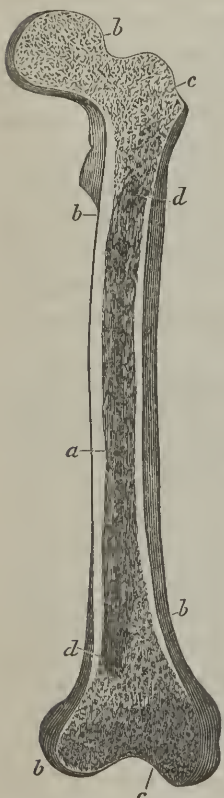
Periosteum.—All of the bones, without exception, are inclosed by a strong fibro-vascular membrane called the periosteum, except those parts incrusted with cartilage. It covers the whole external surface of each bone, to which it is attached by means of little fibrous prolongations, which are received into corresponding pits resembling minute foramina, and by the numerous vessels that pass from one to the other. Besides forming a support or nidus for the minute divisions of the arteries and a medium of attachment between the muscles and bones, there is no doubt that, in the growing subject at least, it secretes the external laminæ of bony matter.

Special Characters of the Different Classes of Bones. Long Bones.—The arrangement of the two kinds of tissue in the long bones, although several times adverted to in the foregoing pages, requires a separate notice. In order to be seen, one of the bones of the extremities, the femur, for example, should be carefully divided in a longitudinal direction, when it will be observed the shaft is composed entirely of compact tissue, forming a hollow cylinder, whose cavity is called the *medullary canal.* This canal is largest at the middle of the bone, from which point it gradually narrows in both directions to its terminations in the spongy or cancellated tissue. The internal surface of its walls is rough, and, at its two extremities, the interlacing of the bony fibres and laminæ presents a beautiful reticulated arrangement, whose interstices are large and continuous with the cells of the spongy tissue. In the recent state, the canal is lined by a delicate and highly vascular membrane, named the medullary membrane, or endosteum, which secretes the medulla or marrow that fills the cavity, and furnishes nutriment to the surrounding osseous tissue. The vessels of this membrane enter and emerge at the nutritious foramen.

The object of the medullary canal is to give greater size and strength to the bone without a corresponding increase of weight, according to a well-known law in mechanics, that the same amount

of material in the form of a hollow cylinder is stronger than when in the solid form. The contained medulla does not, therefore, properly constitute any part of the bone; but is, in some measure, only an accidental constituent. It is entirely wanting in the wing-bones of large birds, where, great lightness being required, the cavity contains nothing but air. In fact, the principal office of the medulla is to render the bones softer and more elastic than they would otherwise be.

Fig. 50.



Longitudinal section of the thigh bone. *a.* Medullary canal. *b.* Compact tissue. *c.* Cancellate or spongy tissue. *d.* Reticulate appearance of the spongy tissue.

The extremities of the long bones are entirely cellular, or spongy, with the exception of a thin layer of compact tissue that forms their external crust, or shell. The cells are large, and communicate freely with each other, and with the medullary canal. They are also lined with a thin vascular membrane, and filled with an oily substance similar to the marrow. Although much larger, the extremities of a long bone do not contain more osseous tissue than the shaft. Two sections of the same length, taken from the shaft and the extremity, have precisely the same weight. The increased *size* of the latter depends entirely upon its more open texture.

Broad Bones.—The broad bones consist of two compact layers or tables inclosing the cancellated or spongy tissue, which, in the bones of the cranium, is known under the name of diploë. The disposition of the two tissues, however, does not materially differ from that of the long bones. The compact tissue is thickest at the centre where the bone itself is thinnest, and the spongy tissue almost or entirely wanting; but near the circumference, where the bone is swollen out, a thin compact crust incloses a considerable amount of spongy tissue.

Short Bones.—The short bones are similar in every respect to the extremities of the long bones. They have a thin external layer of compact substance and spongy tissue within, whose cells are lined by a delicate vascular membrane, and filled with medullary matter.

The *arteries* of the bones are small but numerous. The largest, called the nutritious arteries, enter the nutritious foramina, and are principally distributed to the endosteum. The others enter the small openings formed upon every part of the surface, and a few traverse the large foramina around the extremities of the long and the circumference of the broad bones.

The *veins* are large and numerous, and generally follow the course of the arteries; there is, besides, a special system belonging to the spongy tissue, which pass through large tortuous canals, or sinuses, hollowed out of the bone. These veins have only a single [the internal] coat; they are best seen in the vertebræ and the cranial bones.

Lymphatics have never been demonstrated in the bones, but there is no doubt whatever of their existence. The impossibility of injecting them in opposition to their valves very readily accounts for their not having been seen.

Nerves from the cerebro-spinal system have been traced as far as the nutritious foramina, but never farther. If, however, it is true that the endosteum or medullary membrane possesses sensibility, as affirmed by Duverney, Bichat, and Wistar, there can be no doubt of their presence.

Osteogeny.—Osteogeny, or the development of bone, is one of the most interesting and instructive subjects connected with the whole study of general anatomy; but, in an elementary treatise like the present, not even an outline of the entire process can be given. It must suffice, therefore, to state that, in the earliest stage of fœtal life, the bones, in common with all other organs of the body, exist in the form of a homogeneous mucous or jelly-like mass, which, under the microscope, consists of nucleated cells floating in a semiopaque consistent fluid, or blastema. Out of this mucus temporary cartilages are produced, which have the external forms of the future bones, and in these cartilages the earthy or ossific matter is deposited. The change into cartilage is completed about the end of the eighth week; but before this time, at about the sixth or seventh week, the cartilages of the clavicle and lower jaw are entirely formed, and ossification commences in these parts. A few days later, ossific points may be discovered in the shafts of the femur, tibia, and humerus, and in the upper jaw; next, in the cervical vertebræ, ribs, cranial bones, fibula, scapula, &c. At birth, the bodies of the long bones generally, the bodies and laminæ of the vertebræ, and most of the broad bones are far advanced; some of the tarsal bones have just begun to ossify,

while the extremities of the long bones, the carpal and most of the tarsal bones, give no indication of change for some time after. The whole skeleton is not fully completed until the twenty-fourth or twenty-eighth year.

CUTANEOUS TISSUE.

The skin or common integument invests the external surface of the body, and is continuous, at various points, with the mucous membrane that lines the internal open cavities. Its free surface is in many places studded with hairs, and presents a great number of folds, or wrinkles, resulting from the flexion of parts or from the contraction of subjacent muscles. This surface is also marked by numberless fine ridges and intervening furrows (Fig. 51), produced by rows of

Fig. 51.

Surface of the skin of the palm, showing the ridges, furrows, cross-grooves, and orifices of the sweat-ducts. The scaly texture of the cuticle is indicated by the irregular lines on the surface. Magnified 20 diameters. (Todd and Bowman.)

papillæ to be presently mentioned. Its internal surface is attached to the subjacent parts by areolar tissue, which, in most situations, is sufficiently loose to allow a considerable degree of mobility.

The skin is composed of the *epidermis*, or *cuticle*, with its prolongations in the form of nails and hairs, and the *true skin*, or *corium*, which, besides its proper tactile papillæ, has imbedded in its texture the ducts of the sebaceous and sudoriferous, or sweat-glands.

The *epidermis* has been already described as constituting one of the varieties of epithelium. (See art. *Epithelial Tissue.*) It varies in thickness in different situations and in different individuals, measuring sometimes, in the palms of the hands and soles of the feet, as much as $\frac{1}{6}$ or $\frac{1}{8}$ of an inch, and in other places not more than $\frac{1}{200}$ or $\frac{1}{250}$. Like all other pavement or scaly epithelia, it is composed of nucleated cells and an intercellular blastema. These cells are formed upon the external surface of the corium, or true skin, and have at first a globular outline; but as they are pushed outwardly by others, that are continually forming, they become flattened (Fig. 28), and are ultimately thrown off as thin, hard scales, with a dark spot in the middle indicating the situation of the nucleus. The deep layer of these cells was for a long time considered as a separate structure, denominated the *rete mucosum;* but as it is now known that no such separate structure exists, the name is gradually becoming obsolete. It is in this deep layer that the water collects in blistering, and that we find the pigment-cells or coloring matter that distinguishes the skin of the different races of mankind.

The cuticle is marked upon its under surface by numerous little depressions, corresponding to the tactile papillæ of the corium, and is penetrated by the ducts of the sebaceous and sweat glands on their way to the free surface.

The *corium*, or *true skin* (cutis vera, nervous layer), is covered externally by the cuticle, and is attached to the parts beneath by loose cellular tissue mixed with fat; and, in the soles of the feet and palms of the hands, by strong fibrous prolongations, which attach it to the underlying fascia of these organs. It consists of two distinct parts, namely, a cellulo-fibrous layer and tactile papillæ, besides bloodvessels, nerves, and lymphatics, in the greatest abundance.

The *cellulo-fibrous* or *vascular layer* forms the deepest part of the corium, and is composed of very strong, white, undulating fibres, which cross each other in every direction, and are intermixed with numerous yellow elastic fibres. Upon the inner surface of the layer the fibres are rather loosely disposed, leaving tolerably large interspaces often occupied by adipose cells, but nearer the cuticle; the interlacement is so close and dense, and the fibres so fine, that the interstices cannot be seen with the naked eye. The thickness of this layer varies in different parts of the body, but, as a general rule, is greatest in the most exposed situations, as in the palms of the hands, soles of the feet, &c.

The *papillæ* (Fig. 52) are situated upon the external surface of the corium, and are in contact with the cuticle, to which they give a furrowed and ridged appearance. They are little conical eminences, composed of a fine network of vessels, nerves, and cellular tissue, arranged in rows, which are indicated by the above-mentioned ridges upon the external surface of the cuticle. Their size and number vary in different parts of the body according to the acuteness of the sense of touch in the part. Upon the extremities of the fingers they measure from $\frac{1}{125}$ to $\frac{1}{100}$ of an inch in height, and are so closely arranged as to form a distinct layer; but, upon the trunk of the body, they are few, small, and scattered. In addition to the papillæ there is supposed to exist, upon the external surface of the corium, a fine transparent lamella of amorphous matter, like that found upon the corium of mucous membranes, where it is called the basement-membrane; but this has not been satisfactorily demonstrated.

Fig. 52.

Papillæ of the palm, the cuticle being detached. Magnified 35 diameters. (Todd and Bowman.)

The bloodvessels of the skin are numerous but limited in their distribution to the corium; in this, they form a dense capillary network, from which are given off minute branches to the papillæ. The nerves belong principally to the sensory division of the cerebro-spinal system, and vary in their number according to the degrees of sensibility. In the extremities of the fingers and toes, they are very abundant, and may be traced directly to the papillæ, in which they are said by Gerber to terminate in loops, as represented in Fig. 23.

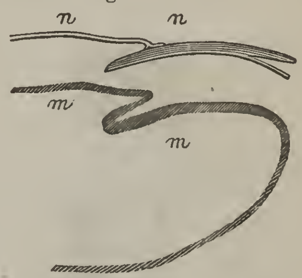
THE HAIR AND NAILS.—The hair and nails are appendages or prolongations of the epidermis, and, like it, are non-vascular and insensible.

The *nails* are hard, translucent, horny plates, situated upon the dorsal aspect of the fingers and toes, and are analogous to the claws and hoofs of the inferior animals. For convenience, each one is divided into three parts: 1. The *root*, or posterior edge, which with the lateral margins are received into an elliptical groove in the corium and are partly concealed by the overlapping of the cuticle (Fig. 53). 2. The *body*, or uncovered portion, which is attached to the true skin by its inferior surface, and presents upon its external surface near the root a white semilunar division, called the lunula. 3. The *free*

edge, which is the portion that projects beyond the anterior line of the attachment of the body.

The surface of the corium to which the nail is attached, including the groove in which the root is lodged, is termed the *matrix*. It is studded with numerous papillæ, which beneath the lunula have no particular arrangement, but, in front of this portion, are placed in longitudinal rows separated by narrow furrows. The nail itself, like the epidermis, is composed of several layers of closely compacted nucleated cells, which next to the matrix are soft, spherical, and surrounded by transparent blastema; but in the middle of the nail, and more particularly on its free surface, they are flattened out, hard, and so compactly and confusedly arranged that it is difficult to discover their outline. The nail being nothing more than ordinary epidermis in a modified form, the two are continuous with each other. The connection occurs upon the upper surface of the organ near its posterior and lateral edges, and upon the under surface, at a little distance from the free margins (Fig. 53).

Fig. 53.

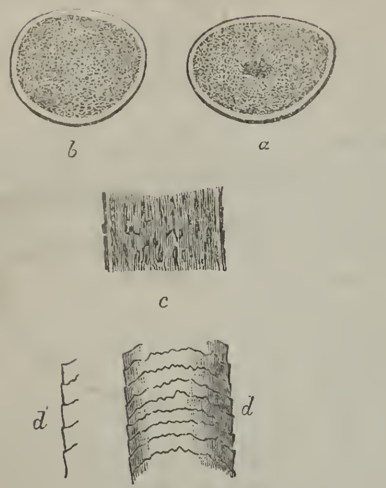


Section of the skin on the end of the finger. The cuticle and nail, *n*, detached from the cutis and matrix, *m*. (Todd and Bowman.)

The *hairs* correspond to the fur, wool, and bristles of the inferior animals, and are nothing more than prolongations or threads of epidermis inserted into the substance of the corium. Each one is said to have a *root*, or bulb, and a free portion, or *shaft*.

The shaft differs in length and thickness in different individuals, and in different parts of the same individual. It is generally longer and finer in the Circassian than in the other races, and finer and shorter upon the trunk and extremities of the body than upon the scalp and face. It is usually cylindrical, but sometimes flattened and grooved; elastic, flexible, non-vascular, and entirely devoid of sensibility. Under the microscope, it is resolved into three parts: 1st, an external covering of fine scales slightly overlapping each other and disposed in regular circles around the circumference (Fig. 54 *d′ d*); 2d, translucent fibres (Fig. 55), which have a general longitudinal direction, and, in the shaft, are so very fine and so closely adherent that they are with difficulty seen even with the best microscopes; 3d, the medulla, or pith, which is an opaque granular substance occupying the centre or axis of the hair.

Fig. 54.



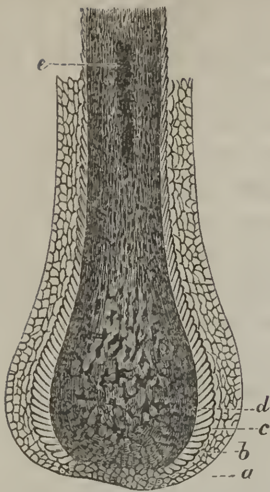
a. Transverse section of a hair of the head, showing the exterior cortex, the medulla or pith with its scattered pigment, and a central space filled with pigment. *b.* A similar section of a hair, at a point where no aggregation of pigment in the axis exists. *c.* Longitudinal section, without a central cavity, showing the imbrication of the cortex, and the arrangement of the pigment in the fibrous part. *d.* Surface, showing the sinuous transverse lines formed by the edges of the cortical scales. *d'.* A portion of the margin, showing their imbrication.—Magnified 150 diameters. (Todd and Bowman.)

Fig. 55.

The fibres of the stem of a hair, magnified 670 diameters.

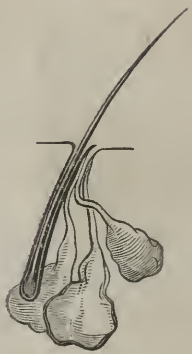
The *root* of the hair (Fig. 56) has a bulbous or clubbed shape, and is inclosed in a corresponding cavity in the skin, called the hair-follicle. This is a simple excavation or recess in the corium, lined, except at its bottom, where it is in contact with the extremity of the hair, by an involution of the cuticle; it communicates laterally with the ducts of one or more contiguous sebaceous follicles (Fig. 57). Its disposition in regard to the root may be seen by making a vertical section of the two after the scalp has been macerated for thirty or forty hours in a solution of carbonate of potash. It will then be seen that the cuticle is continued down the sides of the follicle and into the ducts of the sebaceous glands, and that it is reflected from around the bottom of the former, so as to become continuous with the scaly covering of the hair, which is here called the sheath of the bulb. At the bottom of the follicle, within the reflected borders of the cuticle, the corium is very vascular, and in contact with the fibrous and pithy matter of the bulb. It bears the same relation to this organ that the matrix does to the nail.

Fig. 56.



Represents a scrotal hair highly magnified. The basement membrane of the follicle is seen at *a*; and at *b* is a layer of epidermic cells resting upon it, and becoming more scaly as they approach *c*, which is a layer of imbricated cells forming the *cortex* of the hair. These cells are seen more flattened and compressed the higher they are traced on the bulb. Within the cortex is the proper substance of the hair, consisting at the base of small angular cells, which at *d* become larger, and the bulb thicker in consequence; at the same time the black pigment is blended with them. Above *d* they assume a fibrous character, and become condensed; while at *e* the shaft of the hair is charged with a mass of coloring matter. (Todd and Bowman.)

Fig. 57.



Three sebaceous follicles taken from the skin of the nose, with an attendant hair. The ducts here open upon the cuticle.

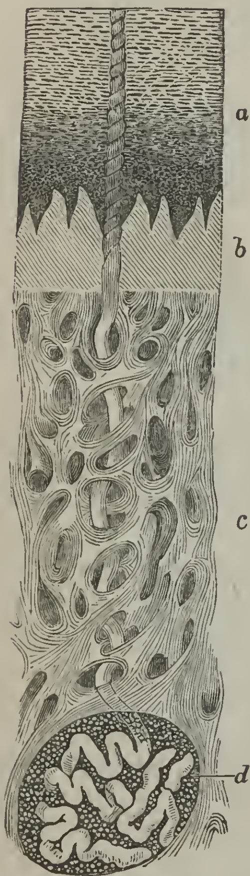
The growth of the hair, like that of the nails and epidermis, takes place, by a successive formation of cells, at the point where the fibrous and pithy matters are in contact with the corium. These cells are at first soft and spherical, but as they are pushed outward they lose these characters in a great measure, and present the appearances just described. The sheath of the hair is, therefore, only the external layer of cells, flattened and dry by exposure. The color of the hair is due to the formation or deposit of pigment in the cells soon after they are generated, and while they still constitute the soft part of the bulb.

Cutaneous Glands.—The glands of the skin are of two kinds, the sebaceous, and the sudoriferous or sweat glands.

Sebaceous Glands. (Fig. 57.)—The simplest form in which these glands appear, is that of a single minute recess or saccule, situated

in the substance of the true skin, and lined by an inversion or prolongation of the cuticle. Generally, however, they are more complex, and consist of several little sacs grouped together and connected with a common duct, which usually opens into a hair follicle, just within its orifice. They are all lined by a delicate membrane continuous with the cuticle, and in all respects analogous to it, and are usually found filled with their peculiar secretion, mixed with detached epithelial cells.

Fig. 58.



Vertical section of the sole of the foot. At *a* is seen the epidermis, more scaly towards the surface, and charged with pigment below; *b* is the papillary body, with its conical terminations projecting into the cuticle; *c* represents the cutis vera, as formed of fibrous tissue into a complex network, and having at its base the convoluted tube which constitutes the sudoriferous gland *d*. It is imbedded in globules of fat, and sends out a duct that can be traced in a spiral form through all the dermoid laminæ until it opens on the surface of the cuticle.

The sebaceous glands exist in greatest numbers upon the scalp and face, especially about the nose, where they are sometimes quite large and their orifices marked by a black speck. Upon the under surface of the eyelids, where they are generally called the *Meibomian follicles*, they are long and tortuous, imbedded in the tarsal cartilages, and open upon the free edges of the lids around the roots of the eyelashes. They are also very numerous around the anus, nipple, and head of the penis, on the scrotum, and in the groins.

The *sudoriferous* or *sweat glands* are among the most recent discoveries of the microscope. They exist in all parts of the external surface of the body, but are most numerous in the palms of the hands and soles of the feet. They are generally larger than the sebaceous glands, and consist of a single fine tube, continued from a funnel-shaped orifice in the free surface of the cuticle to the under surface of the true skin, where it is coiled into a ball or cluster of small reddish saccules. Like the sebaceous glands, they are formed essentially of an attenuated inversion of the cuticle,

strengthened by an outer dermic coat continuous with the corium. They are freely supplied with capillary vessels, and, as their name implies, secrete the sweat.*

MUCOUS MEMBRANE.

This tissue forms the lining membrane of all the cavities of the body that communicate with the external air, and is, therefore, continuous with the skin at the margins of the great outlets, the mouth and anus. It forms by its distribution two great divisions, called the *gastro-pulmonary* and the *genito-urinary*, the several parts of each of which constitute a continuous layer. The gastro-pulmonary commencing at the lips, lines successively the mouth, fauces, pharynx, œsophagus, stomach, and intestines, and furnishes in its course prolongations to the various ducts that open upon its surface; from the throat it is continued upward into the cavities of the nose, the lachrymal passages, and front of the eyes, into the Eustachian tube and internal ear; from the root of the tongue it extends into the larynx, and thence throughout the windpipe, bronchial tubes and air-vesicles of the lungs. The genito-urinary division beginning upon the under surface of the prepuce, covers the neck and head of the penis, lines the urethra and bladder, and is thence continued through the ureters to the pelvis, calyces, and even the minute tubuli of the kidney; from the back part of the urethra, it diverges into the prostatic and ejaculatory ducts, and from the latter extends into the seminal vesicles, and through the defferential and efferential tubes to the primary tubules of the testicle. In the female, it lines the internal surfaces of the labia, the clitoris, vagina, neck, and body of the uterus, and the Fallopian tubes; at the internal extremities of the latter it is continuous with the peritoneum.

In the female, there is a third division connected with the mammary glands, whose ducts are lined by it from their commencement upon the end of the nipple, to their ultimate ramification in the minute lobules of the organ.

* The insensible perspiration is supposed, by Gerber and others, to result from an exhalation of water and other volatile matters from the corium, but the impermeability of the cuticle is opposed to this theory; so that, in all probability, this also is generated by the glands.

The general conformation of the mucous membranes corresponds to that of the surfaces that they cover; but in numerous places they are thrown into folds, some of which are permanent and serve to increase the extent of surface, while others are only temporary or accidental, and are always effaced by the distension of the cavities in which they occur.

The external surface of the mucous membranes is attached to the surrounding parts by common areolar tissue called, from its situation, sub-mucous, which in some places, as in the nose, is short and dense, but in others, loose and open. It is in the latter situations that the temporary folds are found. The internal surface is comparatively smooth, and always covered with the peculiar viscid secretion furnished by the follicles, imbedded in the substance of the membrane.

Mucous membrane is soft and humid, much less resisting than the skin, and in all animals presents a greater or less degree of redness, according to its vascularity and the amount of blood in its vessels at the time of examination. As a general rule, this redness is greater in the infant than in the adult, and, in all ages, is generally greater in the stomach, pharynx, and rectum, than anywhere else. It is impossible, however, to define the shades of difference which the different parts present in a healthy individual; frequent examinations and comparisons of the several portions in different cases can alone furnish this information.

The sensibility of mucous membranes generally is vague and obscure; hence inflammation may produce ulceration or even mortification of the tissue without the manifestation of any great degree of pain, often, indeed, without producing any at all.

Structure.—Mucous membrane, like skin, consists of an epithelial, and a dermic or coroid lamina, together with a set of peculiar little organs called villi or papillæ, and numerous secreting glands. The *epithelium* has been already described. (See art. *Epithelial Tissue.*) The *corium* consists of a dense network of areolar tissue, and vessels, and nerves; hence the name, fibro-vascular layer. It is connected below to the submucous areolar tissue, and is overlaid by the epithelium, a thin transparent membrane called basement or primary membrane, intervening. This basement-membrane cannot, however, be demonstrated in all parts of the mucous system, but only where villi and mucous crypts abound, of which it forms an integral part. Its appearance is that of an amorphous limpid matter, with here and there nuclei and fragments of metamorphosed cells.

The bloodvessels of the mucous membranes are very numerous, and form in the submucous areolar tissue, and in the corium, an intricate network of capillaries, whose arrangement differs according to their situation. From the network minute branches extend into the villi, but none are found in the basement-membrane or epithelium. Intermixed with these vessels are numerous filaments of nerves, belonging mostly to the sympathetic system, and lymphatics or lacteals, which form plexuses beneath the epithelium and basement-membrane, and send branches to the villi.

Mucous Papillæ and Villi.—These are little eminences found upon the free surfaces of some of the mucous membranes, and require a separate description. The *papillæ* are well seen upon the tongue, where they have a conical and cylindrical shape, and are evidently nothing more than prolongations of the corium, freely supplied with vessels and nerves and covered with epithelium. Their office seems to be here connected with the sense of taste. The *villi* are found chiefly upon the mucous membrane of the small intestines, where, indeed, they are so numerous as to give to the surface the appearance and feel of fine velvet. Like the papillæ, they are also mere prolongations of the corium, intended to increase the extent of the membrane without materially increasing its bulk.

Glands.—The little glands, situated in the substance of the mucous membranes, are known by different names in different localities, but they may all be referred to two classes, the simple and the compound.

The *simple glands* or follicles are cavities or depressions in the corium lined by an inversion of the epithelium. They are either tubular or sacculated, and, with some exceptions, they are all provided with excretory orifices. The tubular variety is found in large numbers in the stomach and small intestines, where they are known as the crypts of Lieberkühn, and also in the large intestine and uterus. The sacculated are much larger than the tubular, and may be readily seen with the naked eye. They are distinguished into two kinds, the solitary, and the agminated (glands of Peyer); the former scattered throughout different parts of the alimentary canal; the latter occur principally in the lower part of the small intestines, where they form patches of various sizes; the latter have no excretory orifices.

The *compound glands* are much larger than the preceding, and consist of little vesicles or sacs collected into lenticular masses, provided with branching excretory ducts. Their size is various, but does not usually exceed that of a grain of wheat. They are not placed in

the substance of the mucous membrane, but beneath it in the submucous areolar tissue. They exist in great numbers in the lips, palate, œsophagus, trachea, bronchial tubes, and duodenum. In the last locality they are commonly known as Brunner's glands.

SEROUS MEMBRANES.

The serous tissue is distributed throughout different parts of the body, principally for the purpose of preventing friction between opposed gliding surfaces. It includes, therefore, the serous membranes of the visceral cavities, the synovial membranes of the joints, and the mucous bursæ; but wherever situated, or under whatever name it may be known, it exists as a thin, transparent lamina, forming closed sacs of various sizes. The outer surface of each sac is rough and filamentous for attachment to the surrounding parts, and the internal smooth and moist, and always in contact with itself.

The *serous membranes* line the internal cavities of the body and invest the contained viscera. Each consists, therefore, of a *parietal* and a *visceral* portion; the former, as its name signifies, is connected with the internal surface of tho walls of the cavity, and the latter covers the included organs. The two form, however, but one sac. The principal structures of this class are the arachnoid of the brain and spinal cord, the two pleuræ, the serous pericardium, the peritoneum, and the vaginal tunics of the testes. They all furnish a thin watery secretion in the form of a halitus or vapor from their internal surfaces, which keeps them moist and smooth.

The serous membranes, although differing somewhat in their thickness, are perfectly transparent, the milky or cloudy appearance that they usually present being due to changes after death. They possess a certain amount of extensibility and elasticity, as is proved by their distension in dropsy, and their retraction after the fluid has been removed. In the healthy state they are devoid of animal sensibility and irritability. The acute pain, of which they seem to be the seat when inflamed, belongs, in all probability, to the tissues with which they are in immediate contact.

Structure.—The structure of serous membrane is very simple; it consists: (1) of a layer of condensed areolar tissue; (2) one of basement-membrane, and (3) a delicate epithelium. The *areolar*,

or, as it is sometimes called, the *fibrous layer*, is composed of fascicles of white filaments of the usual wavy appearance, mixed with a few yellow elastic fibres, and forming a network, whose closeness increases from without inward. The *basement-membrane* is a simple, homogeneous, amorphous substance, spread out in an exceedingly thin, transparent layer upon the internal surface of the preceding. Its office, like that of all such structures, is connected in some way as yet unknown with the production of the epithelium beneath which it is placed. The *epithelial layer* (see art. *Epithelia*) belongs to the tessellate or scaly variety, except in the cavities of the brain and upon the fimbriated extremities of the Fallopian tubes, where it is ciliated tessellate.

The bloodvessels and lymphatics of the serous membranes form an open network in the subserous areolar tissue, and in the fibrous layer, but never enter the basement-membrane or epithelium. Nerves may be also detected accompanying the vessels, but they are very few in number.

Synovial Membranes and Bursæ.—The synovial membranes are precisely similar to the serous membranes in their general form and structure, and in the office which they fulfil, namely, that of furnishing smooth surfaces between parts that admit of motion; but they differ from them in situation, and in the character of their secretion, which is a consistent, glairy fluid, not unlike the white of an egg.

Synovial membranes are found: (1) upon the cartilaginous surfaces of the opposed bones in the movable joints, where they are named articular synovial membranes; (2) and they also exist as simple bladders, called mucous bursæ, (*a*) where muscles or tendons pass over bones like a rope over a pulley; (*b*) where muscles play upon each other, or upon other soft parts; (*c*) and between the skin and bony prominences.

The articular synovial membranes line the internal surfaces of the walls of the movable joints, and, in all probability, the cartilaginous surfaces of the opposed bones, although this is doubted by many good anatomists. In some of the joints the membrane forms folds, some of which inclose small masses of fat, while others, with fimbriated margins, float loosely from one part of the cavity to another, and perform no particular office, except that of increasing the extent of surface.*

* Havers supposed these folds to be glandular organs, and this supposition has lately received considerable support in England by the dissections of Mr. Rainey.

The bursæ are flattened bladder-like sacs, each having an external rough surface by which it is attached to the surrounding parts, and an internal smooth surface, moistened by the secreted synovia, and always in contact with itself. The size of the sacs varies when distended from that of a pea to a large walnut, and their number in the whole body is estimated at about 150. In some cases, more or less complete septa are found dividing the sac into several smaller cavities, which may or may not communicate with each other. Such sacs are said to be multilocular.

The bursæ that line the fibrous canals, through which the tendons of the flexor muscles of the hand and foot pass to their insertions (often called *vaginal synovial membranes*), do not differ from the others, except in the complexity of their arrangement, each tendon being inclosed in a synovial tube, reflected in such a way as to line the fibrous canal, and invest the tendon, and yet allow great latitude of motion.

GLANDULAR TISSUE.

The various glands of the body, constituting the glandular tissue or system, are separate organs. Each is provided with one or more canals or ducts, which communicate, upon the one hand, with the ultimate structure of the organ itself, and, on the other, with the free surface of the skin or mucous membranes. According to this definition, the organs composing this system are the liver, kidneys, pancreas, mammæ, testicles, ovaries, the salivary and lachrymal glands, and the numerous crypts or follicles, connected with the skin and mucous membranes. The office of these glands is to form or eliminate from the blood certain matters, that are either reabsorbed partly or wholly or cast off entirely from the body. The process and its product are alike called *secretion.** The secretions that are

* The glands, properly so called, are not the only structures that perform a secretory function. The serous and synovial membranes secrete fluids suited to the wants of the parts they invest, and in the process of nutrition, all the solid tissues of the body select from the circulating fluid materials for their nourishment, and reject others; but in this function, the selected matter enters for a certain time into the structure of the tissues, and the rejected matter comes from their wearing away, whereas in secretion no such incorporation takes place; the eliminated matters are no sooner formed than they are discharged.

reabsorbed are said to be recrementitious, and those that are thrown off, excrementitious; the salivary and pancreatic secretions belong to the former class, and the urine and sweat to the latter.

The simplest form of a gland is that of a single sac-like cavity opening upon a free surface, and lined by a prolongation or inversion of the membrane that covers it. Such are the mucous follicles already described. Compound glands differ from simple ones only in the form and greater extent of their secreting surfaces.

In the sweat glands and the Meibomian follicles, which form a connecting link between the simple and compound varieties, the secreting surface is disposed in the form of a simple tube, coiled upon itself so as to occupy as little space as possible, and to allow the ready access of bloodvessels. Glands of this kind are called tubular. Others, such as the pancreas, salivary, lachrymal, and mammary glands, have a secretory duct that divides and subdivides, and upon its branched extremities and sides are little sacs or saccules, grouped into clusters, these clusters into lobules of various shapes and sizes, and the lobules into larger lobes. This is called the vesicular or racemose variety.

These two varieties, the tubular and racemose, with numerous sub-varieties, include nearly the whole glandular system. The solitary and the agminated, or Peyer's glands, and the liver are the only exceptions; the structure of these, however, has not yet been precisely determined.

The glands are largely supplied with bloodvessels; for, besides the blood that they require for nutriment, a large amount is necessary for the production of their special secretions. The nerves of the glands belong for the most part to the sympathetic system, and enter the several organs along with the bloodvessels.

PART II.

THE BONES AND JOINTS.

OSTEOLOGY.

THE SKELETON.

The physical, chemical, and vital properties, as well as the structure and the distribution of the osseous tissue having been already described (see art. *Osseous Tissue*), it now remains to consider the special characters of the separate bones. It is proper to remark that, since they constitute the fixed points of descriptive and surgical anatomy, the bones are probably of more practical importance than any other structures in the body.

In their natural positions, the bones form a uniform and symmetrical framework called the skeleton, of which the spinal column, connected above with the skull and below with the pelvis, is the centre or axis; to this are appended, above and in front, the ribs, which with the sternum or breast bone constitute the thorax; and four extremities, two superior and two inferior, complete the catalogue.

If we consider as distinct bones only those that are contiguous and not continuous with each other when the body has reached complete development (about the twenty-fifth or thirtieth year), the number of pieces composing the entire skeleton will be 197. Of these—

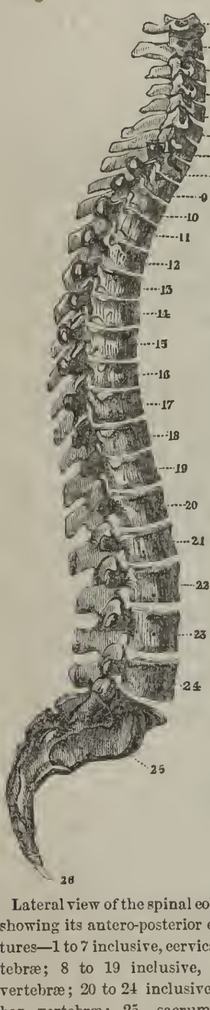
The spinal column, including the sacrum and coccyx, contains		26
The skull (cranium 8, face 14)		22
The thorax (ribs 24, sternum 1)		25
The superior extremities each, including the shoulder	32	64
The inferior extremities each, including the hip-bone	30	60

In this enumeration the hyoid bone, the ossicles of the ear (six in number), the teeth (thirty-two), and the sesamoid bones (generally about eight), are not included.

THE SPINAL COLUMN.

The spinal or vertebral column is composed of twenty-six short bones, which form a long, crooked stem, along the middle of the posterior part of the body. It supports the weight of the head, chest, and the superior extremities, and the greater portion of the abdominal organs. At the same time it constitutes a bony canal for the protection of the spinal cord, and a fixed point for the attachment of numerous muscles. Its whole extent is conveniently separated into four divisions, named after the regions in which they are situated, the cervical, dorsal or thoracic, abdominal or lumbar, and pelvic.

Fig. 59.



Lateral view of the spinal column, showing its antero-posterior curvatures—1 to 7 inclusive, cervical vertebræ; 8 to 19 inclusive, dorsal vertebræ; 20 to 24 inclusive, lumbar vertebræ; 25, sacrum; 26, coccyx.

Of the twenty-six separate pieces, the lowest two of the series are called respectively the coccyx and sacrum, while the remaining twenty-four are known under the common name of vertebræ. The prefix *true* is sometimes added to distinguish them from the coccyx and sacrum, which, being in many respects unlike the others, are occasionally called *false* vertebræ. The cervical portion of the column contains seven vertebræ, the dorsal twelve, and the lumbar five; the pelvic division is composed of only the sacrum and coccyx. Occasionally, however, this distribution is found to vary, six cervical being sometimes combined with six lumbar vertebræ. More rarely the whole number is increased by one, which is usually found in the lumbar region; and in a single remarkable instance of which the author was witness, there were two

additional ones in the cervical, and one in the lumbar division, the sacrum being composed of its usual number of pieces.

General Characters of the Vertebræ.—Each vertebra represents a transverse section of the spinal column, and presents certain characters common to all, which it is necessary to understand before proceeding to an examination of the special characters of each class. Thus, each one consists of a body and processes; the former constitute, as it were, a block of the solid portion of the column, and the latter levers or arms for the attachment of muscles, and eminences for articulation with the bones between which it is placed. Being also a segment of the spinal canal, each piece contains a large opening called the vertebral foramen.

The *body*, the largest part of the bone, is situated in front of the vertebral foramen, and presents for consideration four surfaces, of which the *anterior* is convex transversely, slightly concave vertically, and marked by numerous small openings for the accommodation of veins and arteries; the *posterior* forms the anterior boundary of the vertebral foramen, is somewhat concave from side to side, and presents the orifices of several large venous canals that emerge in this situation; the *superior* and *inferior*, generally of a circular or oval shape, and slightly excavated, articulate by means of a plate of fibro-cartilage with corresponding surfaces upon the bodies of the contiguous bones.

The *processes* are seven in number, namely, two lateral, one on each side, called the transverse; four vertical, two on each side, named the articulating; and one in the median line behind called the spinous. The roots or bases of the first six are blended together on each side, and are continuous with the seventh, the spinous process, by the two laminæ or arches which complete the lateral boundaries of the vertebral foramen. The whole are connected to the body of the bone upon each side of its posterior surface by a narrow strip of bone called the pedicle.

The *transverse processes* start off immediately behind the pedicles and externally to them. Their general direction is horizontal, but their size, shape, and length vary in the different regions. The *articular processes*, two upon each side, namely, a superior and an inferior, arise in common with the preceding just behind the pedicle, the former passing upward and the latter downward; they present smooth surfaces for articulation with the corresponding processes of the contiguous bones, and rough margins for the attachment of ligaments. The *spinous process*, like the transverse, is intended principally as

a lever for the attachment of muscles; it is situated in the median line posteriorly, being connected to the roots of the preceding by means of the laminæ, and it forms a part of that sharp ridge or spine found upon this surface of the spinal column in nearly all vertebrate animals. The *laminæ* are properly the two roots of the spinous process, between which and the bases of the transverse and articulating processes, they extend in the form of two quadrilateral arches, flattened from within outward. They thus present a superior and an inferior edge for the attachment of ligaments of yellow elastic tissue, which connect these portions of the contiguous bones throughout the entire column. The *pedicles*, as already stated, connect the processes with the body; they are grooved or notched above and below, in such a manner that when two contiguous vertebræ are placed in their natural position, openings are formed, called the *intervertebral foramina*, which transmit the spinal nerves. The *vertebral* or *spinal foramen* varies in size and shape in the different divisions of the column, but, in all situations, is large and generally inclined to the triangular form; it is bounded in front by the body of the bone, and laterally and posteriorly by the pedicles, laminæ, and the roots of the transverse, articulating, and spinous processes.

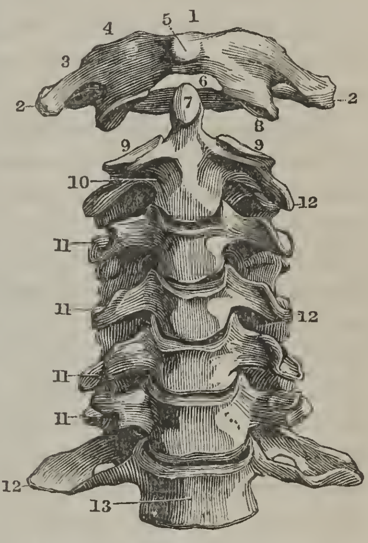
CERVICAL VERTEBRÆ.

The cervical vertebræ are smaller than the others, but gradually increase in size from the second to the seventh. Their body is longest in its transverse diameter, and a little deeper before than behind; the superior surface is made concave from side to side by two lateral ridges or crests, within which the corresponding portion of the bone above is received; the under surface is concave from behind forwards, and its lateral margins are rounded. The *vertebral* or *spinal* opening is triangular in shape and proportionally larger than in the other groups, measuring eleven lines transversely and six antero-posteriorly. The pedicles are very short, and cannot be readily distinguished from the roots of the transverse processes. The notches are small and of almost equal depth, the superior being, probably, a very little deeper than the inferior.

The *articular processes* are continuous with each other at their roots, forming little pillar-like masses, whose superior and inferior smooth surfaces are flat and oblique in their direction, the former

looking upwards and backwards, the latter downwards and forwards. The *transverse processes* are short, deeply grooved superiorly for the lodgement of nerves, and perforated at their bases for the passage of the vertebral arteries (see Fig. 61); they have, therefore, two superior borders, and properly two roots, one in front of and the other behind the arterial opening; the anterior one is connected to the side of the body, and is on a line with the ribs of which it is the cervical representative; the posterior joins the roots of the articular processes. The *spinous process* is short, triangular, prismatic, bifurcated at its extremity, grooved inferiorly, and horizontal in its direction. The *laminæ* are long and thin, especially at their upper borders, which are longer and sharper than the inferior; their two surfaces are not vertical, but inclined from above downward and backward, so that when the bones are together the inferior edge of each will be found to overlap the superior edge of the bone below in the form of a true imbrication.

Fig. 60.



Anterior view of the cervical vertebræ. 1. Atlas. 2. Transverse process of atlas. 3. Foramen for the vertebral artery. 4. Articular surface for the occipital condyle. 5. Tubercle of the atlas. 6. Spinal canal. 7. Odontoid process of the axis. 8, 9. Oblique or articulating processes of the atlas and axis. 11. Grooves in the transverse processes for the spinal nerves. 12. Transverse processes. 13. Body of vertebræ.

The *atlas*, the first of the cervical vertebræ, counting from above, differs from the others in several particulars, of which the most important is the absence of both body and spinous processes. In the place of a body there is a small long plate denominated the *anterior arch*, whose front surface is marked by a small tubercle, and the posterior or internal by a smooth, oval, concave facet, for articulation with the tooth-shaped (odontoid) process of the bone below. The superior and inferior margins of this arch give attachment to ligaments. The spinal foramen is larger than that of any other vertebra, and in the recent state is divided by a small transverse ligament, whose extremities are attached to little rough surfaces situated upon the inner side, and below the superior articular processes; the anterior or smaller division is occupied by the odon-

toid process of the axis; the posterior is a section of the spinal canal. The notches are situated immediately behind the articular processes, instead of in front, as in all the other vertebræ; the superior notch, deeper than the inferior, is often converted into a foramen by a delicate bony ridge, and winds around the articular process in the direction of the opening in the transverse process; it is occupied by the first cervical nerve and the vertebral artery. The articular processes are very thick and strong. The two superior, which receive the occipital condyles, are deeply concave and oval from before backward and outward, and look upward and inward; the inferior, circular and nearly plain, look downward and a little inward.

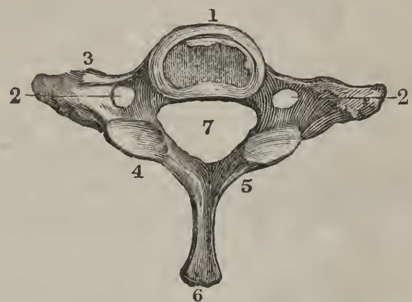
The transverse process on each side is long, triangular, terminated externally by an obtuse point, and perforated at its root by the arterial foramen, which is large, and directed upward and backward.

The laminæ are long and thick, and complete the spinal foramen behind in the form of a *posterior arch*, upon whose outer surface, and in the median line, is a small tubercle, the representative of a spinous process.

The second cervical vertebra, called the *dentatus* or *axis*, is principally remarkable for the large odontoid (tooth-like) process (Fig. 60) which surmounts its body. This process forms a cylindrical pivot, upon which the rotary movements of the head are performed. It presents upon its anterior and posterior surfaces articular facets, corresponding to the anterior arch and transverse ligament of the atlas between which it is received. Its base is broad and firm, its middle somewhat constricted, and its summit rough, for the attachment of the check ligaments. The body is marked in front by a median vertical ridge, and upon each side of this by a slight excavation for the attachment of the anterior long muscle of the neck. The spinal foramen is heart-shaped (cordiform) and very large, and corresponds in this respect to the great latitude of motion between this vertebra and the atlas. The superior notches are very superficial, and situated behind the superior articular processes, which are large, nearly horizontal, but a little inclined outward, and situated upon the body of the bone on each side of the odontoid process. The transverse processes are small, triangular, and bent downward; they are neither grooved nor bifurcated, and the foramen, which is here more properly a canal, is directed upward, outward, and backward. The spinous process is broad and thick, triangular prismatic in shape, and extends horizontally backward to a considerable distance; it is channelled beneath to accommodate the superior edge of the same process of the

bone below, and terminates by two tubercles for the attachment of muscles. The laminæ correspond in size and strength to the spinous process.

Fig. 61.



The lower surface of the seventh cervical vertebra. 1. Body. 2. Foramen for the vertebral vein. 3, 4. Articulating processes. 5. Lamina, or bony bridge. 6. Spinous process. 7. Spinal foramen.

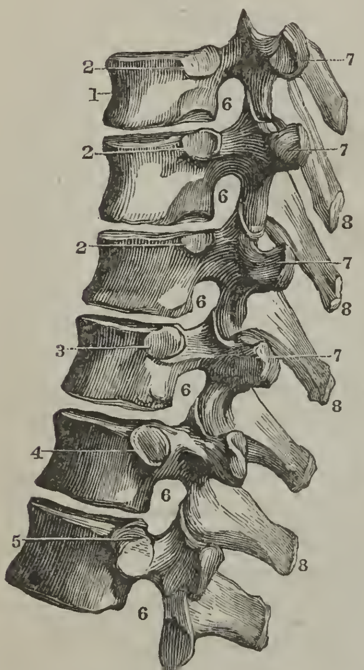
The seventh cervical vertebra differs from the others of its class in possessing many of the characters of the dorsal group. Its *body* is large, its spinal foramen more nearly circular than triangular, the facets of its articular processes are almost vertical; its transverse process, although grooved and perforated, is seldom bifurcated; its spinous process is long, tuberculated at its extremity, and projects so far beyond the others as to be readily felt through the skin. The foramen in the base of the transverse process is never traversed by the vertebral artery.

DORSAL VERTEBRÆ.

The dorsal vertebræ, twelve in number, are intermediate in situation and size between the cervical and lumbar; they decrease, however, from the first to the fourth, but from the latter increase successively, so that the fourth and fifth are the smallest, and the twelfth the largest. Their bodies are a little longer transversely than antero-posteriorly, thicker behind than before, flat and plain above and below, convex in front, but concave behind; on the back part of each side are two small facets (Fig. 62, 2), one above and the other below, which form with the corresponding parts of the contiguous vertebræ, smooth, oval-shaped excavations for articulation with the heads of the ribs. The spinal foramen is smaller than in the other groups, and circular.

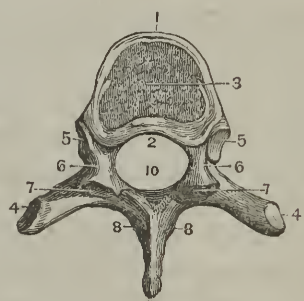
The articular processes are vertical, the superior having their articulating surfaces turned directly backward, and the inferior forward. The transverse processes are thick, strong, somewhat tubercular, and bent obliquely backward; upon the anterior part of their extremities is a smooth, shallow excavation (Fig. 63, 4), for articulation with the tubercle or shoulder of the rib above. The spinous processes are triangular

Fig. 62.



Lateral view of the six inferior dorsal vertebræ. 1. Body of the vertebra. 2, 2, 2. Rib-depressions formed in contiguous vertebræ. 3, 4, 5. The three last dorsals, in which the pit for the head of the rib is formed entirely in its respective vertebra. 6, 6. Intervertebral foramina. 7, 7. Articulating facets of the transverse processes, for receiving the tubercles of the ribs. 8, 8. Spinous processes. 9. Articulating or oblique process.

Fig. 63.



Upper surface of the sixth dorsal vertebra. 1. Annular or marginal ring. 2. Spinal surface of the body. 3. Body. 4, 4. Transverse processes with articular facets. 5, 5. Half pits for the heads of the ribs. 6, 6. Laminæ. 7, 7. Oblique or articulating processes. 8, 8. Junction of the laminæ to form the root of 9, the spinous process. 10. Spinal foramen.

prismatic, long, tuberculated at their extremities, and nearly vertical, so that when the bones are in position the groove on the under edge of the process above receives the upper edge of the one below. The pedicles present a very slight notch upon their superior margins and a very deep one underneath.

The *first dorsal vertebra* possesses many of the characters of the cervical group. Its body is considerably elongated transversely, concave upon its upper surface, and presents an entire facet for the head of the first rib, and a small part of another for the second. The *tenth*, *eleventh*, and *twelfth* approximate in character to the lumbar; the

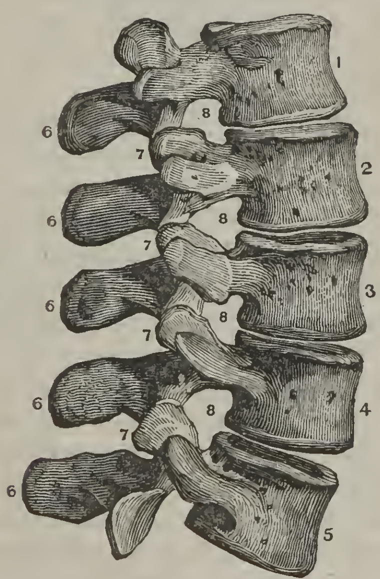
body of each is large, somewhat transversely elongated, and is marked upon each side by an entire facet (Fig. 62, 4, 5, 6) for the corresponding rib. The transverse processes are very short, and the eleventh and twelfth want the articulating surface. The spinous process is horizontal, strong, and nearly quadrilateral.

LUMBAR VERTEBRÆ.

The five lumbar vertebræ are the largest in the column. Their bodies are much broader transversely than antero-posteriorly, thicker in front than behind, flat above and below, and, like the cervical, grooved or constricted anteriorly and at the sides. The vertebral foramen is large and triangular.

The pedicles are very short, thick, and strong, with well-marked notches of which the inferior are the deeper. The articular pro-

Fig. 64.



Lateral view of the five lumbar vertebræ. 1 to 5. Bodies of the vertebræ. 6, 6. Spinous processes. 7, 7. Articulating processes. 8, 8. Intervertebral foramina for the lumbar nerves.

cesses are broad, strong, and vertical in their direction; the facets of the superior are concave and present backward and inward; those of the inferior are convex, turned forward and outward, and are so

much nearer the median line than the superior as to be received within those of the bone below. The transverse processes are long, thin, horizontal, and bent but very little backward. The spinous processes are flattened from side to side, quadrilateral in shape, directed horizontally backward, and terminated by rough vertical borders. The laminæ are thick and broad, but very short.

The *last lumbar vertebra* is somewhat different from the others; its body is remarkably wedge-shaped, being, as it were, cut away below from behind forward and downward; its transverse processes are generally large; and its inferior articular processes have a flat facet, which looks directly forward.

THE SACRUM.*—The sacrum, the largest of the spinal bones, forms the posterior median wall of the pelvic cavity where it is inclosed by the innominate bones on its sides, the lumbar vertebræ above, and the coccyx below. It is quadrangular pyramidal in shape with its base presenting upward, somewhat flattened from before backward, curved, with its concavity forward, and when in position is directed obliquely downward and backward, forming with the lumbar vertebræ an obtuse angle whose projection is called the promontory. Its four surfaces and its base and apex require a separate consideration.

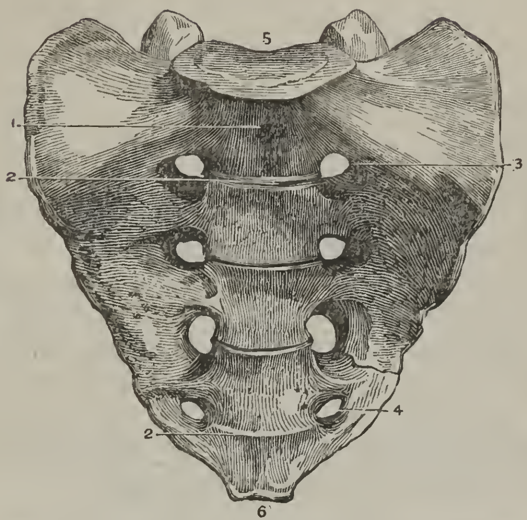
The *anterior* or *pelvic surface* is concave from above downwards, and slightly so from side to side. It is marked in the median line by four transverse lines or ridges, which correspond to the points of union between the separate pieces of which the bone was originally formed. At the extremities of these ridges are the four pairs of large circular holes called the *anterior sacral foramina*, which decrease in size from the uppermost; they transmit the anterior sacral nerves, veins, and small arteries. External to these are superficial horizontal grooves for the nerves to rest upon, and between them smooth spaces from which the pyriform muscles take their origin. The degree of concavity of this surface is subject to great diversity in both sexes, and is probably not characteristic of either.

The *posterior surface* is convex and somewhat narrower than the anterior. It presents in the median line a prominent ridge (sacral ridge) formed by the connection of four processes analogous to the spinous processes of the vertebræ; its lower extremity is bifurcated, and constitutes the borders of the inferior opening of the sacral

* So called from the ancient practice of offering this part of the victim in sacrifice.

canal. Upon each side of this ridge is a large longitudinal groove (sacral groove), bounded externally by a raised edge corresponding

Fig. 65.



Anterior view of the sacrum. 1. First bone of the sacrum, to which the four inferior pieces follow consecutively. 2. Lines of union between the several pieces. 3. The upper, and 4, the lower sacral foramina. 5. Surface for articulation with the last lumbar vertebra. 6. Articulating surface for the coccyx.

to the transverse processes of the vertebræ; in the middle of the groove is another vertical ridge corresponding to the articular processes, and upon the outside of this are the four *posterior sacral foramina*, smaller than the anterior, and intended for the transmission of the posterior sacral nerves together with a few veins and small arteries.

The triangular *lateral surfaces*, broad above and narrow below, where they form sinuous borders, slope obliquely from above downward and inward, and from before backward and inward, so that the bone is wedge-shaped in two directions. The upper part of each of these surfaces presents a large ear-shaped (auricular) surface for articulation with the ilium, and behind this, a number of small, rough, angular prominences for the attachment of strong ligaments. The border below gives attachment to the sacro-ischiatic ligaments.

The *base*, or superior extremity, presents, *in front*, an oblique, transversely oval, and plain surface for articulation with the body of the fifth lumbar vertebra; *on each side*, a broad, flaring, shoulder-like surface, triangular in shape, convex, smooth, and continuous with

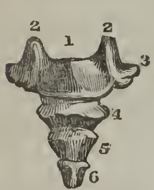
the fossa of the ilium; *behind*, the triangular opening of the sacral canal, the borders of which are formed by two laminæ terminating in the sacral ridge. Between the oval surface and the laminæ are the articular processes, which stand vertically upward with their smooth faces looking backward to join the corresponding parts of the last lumbar vertebra. In front of each of these processes is a groove which forms a part of the last lumbar intervertebral foramen.

The *apex* is blunt, directed downward and forward, and presents a transversely oval and convex surface for articulation with the coccyx. Behind this is the termination of the sacral canal, whose borders end in two small tubercles called the sacral horns (cornua), which articulate with corresponding eminences upon the coccyx.

The *sacral canal*, the continuation of the spinal canal, follows the curve of the bone. It is triangular prismatic and large above, diminishes rapidly as it descends, and communicates with the anterior and posterior foramina. Its posterior wall is wanting inferiorly, but in the recent state the deficiency is made up by ligamentous bands stretched from side to side. The canal lodges the sacral nerves which emerge at the two sets of openings.

THE COCCYX.—The coccyx is composed of three or four separate pieces analogous to the tail bones of the lower animals. They diminish successively in size from above downward, the last being a mere nodule. When taken together they form a triangular, pyramidal bone, flattened from before backward, and articulated by its base to the extremity of the sacrum. Its *anterior surface* is smooth, concave from above downward, and marked by transverse lines indicative of its division; the *posterior*, or subcutaneous surface, is rough for the attachment of ligaments, and also marked by transverse lines.

Fig. 66.



Posterior view of the coccyx. 1. First piece forming the base which articulates with the sacrum. 2, 2. Horns (cornua). 3. Notch for the fifth sacral nerve. 4. Second piece. 5. Third piece. 6. Fourth piece.

The *sides* or *borders* are thin and sinuous, and give attachment to the coccygeal muscles and the sacro-sciatic ligaments. The *base* presents a transversely oval, concave surface for articulation with the sacrum, and behind this, two vertical eminences (cornua), which articulate with corresponding projections upon the lower back part of the sacrum. Upon the outside of these are two *notches*, converted into foramina in the recent state by ligaments, and occupied by the last (fifth) sacral nerve. The *apex* is

blunt and tubercular, sometimes bifurcated, and often bent to one side or the other. In old persons this bone is frequently found anchylosed with the sacrum.

THE VERTEBRAL COLUMN IN GENERAL.

The vertebral column, as before mentioned, limits the extent of the trunk of the body; but its length does not correspond to the height of the individual, or to the extent of the spinal cord, which organ, in fact, rarely reaches below the first lumbar vertebra. Measured along its curves in the adult after the twenty-fifth year, its length is about twenty-seven or eight inches. In a straight line from the atlas to the point of the coccyx it is about two inches less. These dimensions do not differ materially in the tallest and shortest persons, the relative height depending principally upon the lower extremities.

The distribution of the length among the different regions is as follows: the cervical portion, five and a half inches; the dorsal, ten inches; the lumbar and sacro-coccygeal, each about six and a quarter inches.

Although the general direction of the column is vertical, it presents several alternate antero-posterior curves, which depend, with the exception of the last, on the different degrees of thickness of the anterior and posterior parts of the bodies of the vertebræ, and the intervertebral fibro-cartilage. The order in which these occur is as follows: in front, a convexity in the cervical region, a concavity in the dorsal, a convexity in the lumbar, and a concavity in the pelvic portion.

The relative degree of these curves is always the same, so that when one becomes increased the others will be found to correspond. Their use consists in the greater strength which they give to the column in a vertical direction, according to a well-known law in physics, that of two rods of equal size, one curved alternately and the other straight, the former will support a much greater weight placed upon its sides in the vertical direction.

Besides the antero-posterior curvatures, a slight lateral one generally exists in the upper part of the dorsal region, presenting its convexity towards the right side. It is not yet conclusively decided whether this is owing to the aorta, whose arch is situated close upon the left side of the column at this point, or, as suggested by Bichat,

to the effect of a greater amount of muscular traction toward the right side, the right arm being generally more muscular than the left.

The shape of the vertebral column resembles that of two unequal and irregular pyramids united at their bases; the superior is formed by the true vertebræ, and presents a constriction in the upper dorsal region; the inferior consists of the sacrum and coccyx.

Viewed from before, the column presents the bodies of the vertebræ ranged one above another, each grooved transversely, separated in the recent state by a thick disk of fibro-cartilage, and covered by the anterior common ligament, which binds them all together. *Posteriorly* may be observed: 1. In the median line, the spine or crest formed by the spinous processes, which vary in size, form, and direction in the different regions, as already described. It may be here mentioned that these differences should be carefully studied, since it is the only part of the column that can be examined in the living subject, with reference to dislocations and diseases. 2. On the sides of the crest or ridge are the two vertebral grooves, shallow above, broad and deep in the dorsal and lumbar regions, and contracted at the lower part of the sacrum. They are bounded laterally by the transverse processes, closed at the bottom by the long laminæ and their connecting elastic ligaments, and occupied by large muscles. The vertebral or spinal canal extends the whole length of the column, and accurately follows its curves, but differs in its shape and size. Thus it is triangular in the neck and loins, and circular in the dorsal region, and largest in the cervical and lumbar divisions.

THE SKULL.

The skull, by far the most complicated part of the skeleton, is composed of a large number of bones of various sizes and shapes, all accurately and curiously joined together for the support and protection of many important and delicately organized structures. It is of an oval shape, flattened upon its sides, larger behind than before, and consists of two parts, the *cranium* and *face;* the former incloses the brain and its membranes, and the latter the organs of the senses.

The cranium, which may be regarded as an expansion of the spinal column, consists of eight separate bones, viz., the occipital, two parietal, the frontal, two temporal, the sphenoid, and the ethmoid.

THE OCCIPITAL BONE.

The occipital belongs to the class of broad or flat bones, and constitutes the posterior and inferior middle part of the cranium. It is symmetrical, quadrilateral in shape, and has an external and an internal surface, four borders and four angles.

The *external surface* (Fig. 67) is convex, and divisible into two parts, the superior or cutaneous and the inferior or basilar; the

Fig. 67.

The external surface of the occipital bone. 1. The superior curved line. 2. The external occipital protuberance. 3. The spine. 4. The inferior curved line. 5. The occipito-spinal foramen. 6: The condyle of the right side. 7. The posterior condyloid fossa, in which the posterior condyloid foramen is found. 8. The anterior condyloid foramen, concealed by the margin of the condyle. 9. The jugular eminence. 10. The notch in front of the jugular eminence which forms part of the jugular foramen. 11. The basilar process. 12, 12. The rough projections into which the odontoid ligaments are inserted.

former constitutes that part of the skull known as the occiput, the latter forms a part of the base. Upon this surface, a *vertical ridge* extends from the posterior margin of the occipital foramen to a rough prominence called the *external occipital protuberance*, situated about midway between the occipital foramen and superior angle. The two slight ridges extending outwardly in an arched line, one from the protuberance and the other from the middle of the vertical ridge, are distinguished as the *superior* and *inferior curved lines*, and, together with the included rough surfaces, give attachment to muscles. The *occipital condyles*, two smooth, convex, oblong eminences, are situated upon the sides of the occipito-spinal foramen, a little in front of its transverse axis, and are intended to articulate with the atlas. Two small shallow depressions, called the *anterior*

and *posterior condyloid fossæ*, are situated, one in front of, and the other behind the condyles; at the bottom of each there is a foramen of the same name, the posterior transmitting a small artery and vein, and the anterior the ninth or hypoglossal nerve. In front of the occipital foramen the bone is thick and strong, forming what is named the *basilar process.*

The *internal* or *concave surface* (Fig. 68), is marked behind or rather above the great foramen by the *crucial ridge;* it consists of

Fig. 68.

The internal surface of the occipital bone. 1. Left cerebral fossa. 2. Left cerebellar fossa. 3. Groove for the posterior part of the longitudinal sinus. 4. Vertical ridge for the attachment of the falciform process of the cerebellum. 5. Groove for the first part of the left lateral sinus. 6. Internal occipital protuberance. 7. Occipito-spinal foramen (foramen magnum). 8. Basilar process. 9. Groove for the terminal portion of the lateral sinus, bounded externally by the jugular process. 10. Jugular fossa, connected with the jugular foramen by the petrous portion of the temporal bone. 11. Superior lateral border. 12. Inferior lateral border. 13. Border for articulation with the petrous portion of the temporal bone. 14. Anterior condyloid foramen.

a vertical and a horizontal arm, which intersect each other at right angles, and form a rough prominence named the *internal occipital protuberance* (6). These ridges divide the surface into four shallow excavations, the *occipital fossæ*, of which the superior pair correspond to the posterior lobes of the cerebrum, and the inferior to the hemispheres of the cerebellum. The broad superficial grooves observed upon the superior half of the vertical ridge, and on both divisions of the horizontal, lodge the corresponding parts of the superior longitudinal and lateral sinuses of the dura mater. On each side of the occipital foramen is the internal opening of the anterior condyloid foramen or canal, and a little behind and external to it is the termi-

nation of the large groove for the lateral sinus. In front of the occipito-spinal foramen, the basilar process presents a broad, shallow antero-posterior excavation, whose sides slope from before downward and backward.

The *occipito-spinal foramen* (foramen magnum) is the superior orifice of the spinal canal; it is oval in an antero-posterior direction, larger internally than externally, and transmits the spinal cord and its membranes, the vertebral arteries, and the accessory nerves.

The *superior borders* of the bone are closely dentated for articulation with the parietal bones, and often present small separate pieces called *Wormian bones* (ossa Wormiana or triquetra). The *inferior* borders join the temporal bones, and are each interrupted about the middle by a projection termed the *jugular eminence*, immediately in front of which is the deep *jugular notch or fossa* (10); this, with a similar but smaller notch upon the contiguous edge of the temporal bone, forms the jugular foramen (posterior foramen lacerum).

The acute *superior angle* is received between the posterior borders of the parietal bones; the *inferior*, formed by the basilar process, is thick, quadrilateral, and rough, and joins the body of the sphenoid bone; the two *lateral* are obtuse, and fit into the concavity formed on each side by the posterior borders of the parietal and temporal bones.

The occipital, like the other broad bones of the cranium, is composed of two dense laminæ or tables of compact tissue, and an intervening diploë or spongy portion. It articulates with five bones of the cranium, viz.: two parietal, two temporal, the sphenoid, and with the first cervical vertebra.

THE PARIETAL BONES.

The parietal bones, two in number, occupy the lateral and superior parts of the cranium; they are broad and quadrilateral, and have each two surfaces, four borders and four angles.

The *external surface* is convex, particularly just above its centre, where it forms a kind of prominence well-marked in children, called the *parietal protuberance.* Just below this the bone is traversed antero-posteriorly by a curved, slightly raised line forming a part of the *temporal ridge*, which gives attachment to the temporal aponeurosis. Above the ridge the surface is smooth and nearly subcuta-

neous; beneath it is rough for the origin of the temporal muscle. The *internal surface* is concave, and marked throughout by numerous little prominences and depressions corresponding to the convoluted

Fig. 69.

The external surface of the left parietal bone. 1. The superior or sagittal border. 2. The inferior or squamous border. 3. The anterior or coronal border. 4. The posterior or lambdoidal border. 5. The temporal ridge; the figure is situated immediately in front of the parietal eminence. 6. The parietal foramen, unusually large in the bone from which this figure was drawn. 7. The anterior inferior angle. 8. The posterior inferior angle.

surface of the brain, and by arborescent grooves, most of which converge toward the anterior inferior angle, where a complete canal is formed in the substance of the bone for the main trunk of the middle meningeal artery. Near the superior border is a superficial antero-posterior furrow (Fig. 70, 5), which is the half of a broad shallow

Fig. 70.

The internal surface of the left parietal bone. 1. The superior or sagittal border. 2. The inferior or squamous border. 3. The anterior or coronal border. 4. The posterior or lambdoidal border. 5. Part of the groove for the longitudinal sinus. 6. The internal termination of the parietal foramen. 7. The anterior inferior angle of the bone, on which is seen the groove for the trunk of the middle meningeal artery. 8. The posterior inferior angle, upon which is seen a portion of the groove for the lateral sinus.—W.

groove for the superior longitudinal sinus.* Along this groove are a number of small circular and oval depressions occupied by the Pacchionian bodies, and a foramen, often wanting, which transmits a vein from the scalp. Upon the inner side of the posterior inferior angle is also a broad but short groove for the lateral sinus which crosses the bone at this point (8).

The *superior border*, the longest of the four, is nearly straight, and deeply serrated for union with the opposite bone. The *inferior*, the shortest, is very thin, concave, and cut away, as it were, externally for the overlapping of the squamous portion of the temporal bone with which it is articulated. The *anterior*, thicker than the inferior and dentated or serrated, joins the frontal bone and overlaps it below, but is slightly overlapped by it above. The *posterior*, the thickest and most closely serrated, joins the corresponding border of the occipital bone.

Of the four *angles*, the two *superior* and the *posterior inferior* are nearly square, but the *anterior inferior* is long and narrow, being received between the frontal and sphenoid bones, the latter of which it overlaps. Upon the inner side of this angle is the canal for the middle meningeal artery.

Like the other cranial bones, the parietal is composed of two tables of compact tissue and an intervening diploë or spongy tissue, the former nearly in contact with each other where the bone is thinnest, which is generally at the depressions occupied by the Pacchionian bodies, and at the parietal protuberance.

THE FRONTAL BONE.

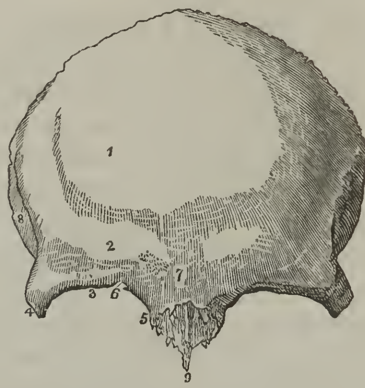
The frontal bone forms the anterior wall of the cranium, and enters somewhat also into the composition of the face. It is symmetrical, irregularly concavo-convex, and bears some resemblance in form to a bivalve shell. It consists of a vertical or frontal, and a horizontal or orbital portion, each having two surfaces and articulating borders.

Vertical Portion.—The *external surface* is nearly regularly convex, and presents in the median line a kind of raphé, or sometimes even a regular suture, indicating the development of the bone by two halves. Upon each side of this middle line, the surface is raised

* Very frequently this groove is entirely upon one bone, the sinus not always occupying the precise median line.

into a slight prominence called the *frontal eminence*, which is particularly well seen in young persons. At the lower extremities of the median line is a well-marked elevation named the *nasal tuberosity* or *glabella* (Fig. 71, 7), from which two slight elevations, called the

Fig. 71.



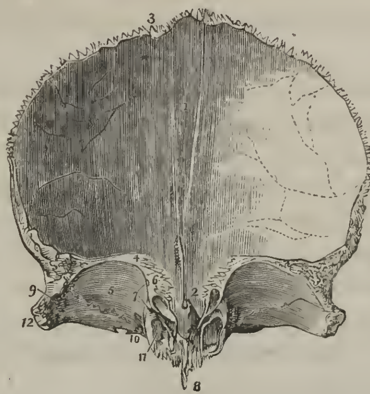
The external surface of the frontal bone. 1. The situation of the frontal eminence of the right side. 2. The superciliary ridge. 3. The supra-orbital ridge. 4. The external angular process. 5. The internal angular process. 6. The supra-orbital notch for the transmission of the supra-orbital nerve and artery; in the figure, it is almost converted into a foramen by a small spiculum of bone. 7. The nasal tuberosity; the swelling around this point denotes the situation of the frontal sinuses. 8. The temporal ridge, commencing from the external angular process (4). The depression in which the figure 8 is situated is a part of the temporal fossa. 9. The nasal spine.

superciliary ridges (2), pass outward in arched lines beneath the frontal eminences; they are much more prominent in some persons than in others. From the middle of the free border of the glabella, which is rough and jagged for articulation with the nasal and superior maxillary bones, a small process, the *nasal spine*, projects downward to join the perpendicular plate of the ethmoid bone behind. Below the superciliary ridge of each side, the margin of the bone is smooth and concave, forming what is called the *orbital arch*, whose extremities are denominated respectively the *internal* and *external angular processes;* the former joins the nasal process of the superior maxilla and the unguiform bone, and the latter the malar bone. About the inner third of each supra-orbital arch is the *supra-orbital notch* (6) (sometimes a foramen), which gives passage to an artery and a nerve of the same name. Behind, and terminating in the external angular process, is the prominent anterior extremity of the temporal ridge.

The *internal surface* is deeply concave, and presents in the median line a ridge with a groove upon it for the attachment of the falciform

process of the dura mater, and lodgement of the superior longitudinal sinus, which has its commencement in a small blind canal (foramen

Fig. 72.



The internal surface of the frontal bone; the bone is raised in such a manner as to show the orbito-nasal portion. 1. The grooved ridge for the lodgement of the superior longitudinal sinus and attachment of the falx. 2. The blind foramen. 3. The superior or coronal border of the bone: the figure is situated near that part which is bevelled at the expense of the internal table. 4. The inferior border of the bone. 5. The orbital plate of the left side. 6. The cellular border of the ethmoidal fissure. The blind foramen (2) is seen through the ethmoidal fissure. 7. The anterior and posterior ethmoidal foramina; the anterior is seen leading into its canal. 8. The nasal spine. 9. The depression within the external angular process (12) for the lachrymal gland. 10. The depression for the pulley of the superior oblique muscle of the eye; immediately to the left of this number is the supra-orbital notch, and to its right the internal angular process. 11. The opening leading into the frontal sinuses; the leading line crosses the internal angular process. 12. The external angular process. The corresponding parts are seen on the other side of the figure.—W.

cœcum) that terminates the groove below. The two fossæ separated by the median ridge correspond to the external eminences, and are occupied by the anterior lobes of the cerebrum.

Orbital portion.—This division of the bone consists of two thin triangular plates called the *orbital processes*, which stand back horizontally from the arches of the orbits to form their roof.

The *superior surface* of each is convex and mammillated, and supports the anterior lobes of the brain. The *inferior* is smooth, concave, and marked near the external angular process by a slight fossa for the lachrymal gland, and near the internal, by a very small depression for the attachment of the cartilaginous pulley of the superior oblique muscle of the eye. The *inner margins* of the two plates are separated from each other by a quadrangular deep notch (ethmoidal notch), which receives the cribriform plate of the ethmoid bone; upon its margins are numerous half cells, which are completed by similar excavations in the latter bone, and also two minute notches

constituting half of the *anterior* and *posterior orbital foramina;* the former of which gives passage to the nasal branch of the ophthalmic nerve and the anterior ethmoidal artery, and the latter to the posterior ethmoidal artery and vein. The *outer* margins are thin and finely serrated, and articulate with the lesser wings of the sphenoid bone.

The vertical portion of the frontal, like the parietal and occipital bones, consists of two tables and an intervening diploë; in the nasal eminence and beneath the superciliary ridges, however, the diploic structure is wanting, and in its place are two considerable cavities called the *frontal sinuses*, which are separated by a thin bony septum and lined by mucous membrane; they communicate through the anterior ethmoidal cells with the cavity of the nose. These cavities do not exist in young persons, but are developed, as age advances, by a separation of the external from the internal table of the bone, and sometimes attain a very large size.

THE TEMPORAL BONES.

The temporal bones are situated in the middle of the sides and base of the cranium. Their form is very irregular, and for convenient reference they are divided into three parts, called respectively the squamous, mastoid, and petrous parts.

The *squamous part* is situated above the other divisions, and forms the lateral wall of the cranium below the parietal bone; it is flattened and semicircular, and presents for consideration two surfaces and a free border. Its *external surface* forms a part of the temporal fossa; it is convex, smooth, marked by small vascular grooves, and, in the recent state, covered by the temporal muscle. At its lower part is a remarkable process, called the *zygoma* or *zygomatic process* (Fig. 75, 2), which stands out horizontally from the bone by a broad base, and turns almost immediately forward, becomes narrow and flattened from within outwards, and, having arrived opposite the anterior border of the bone, terminates in a bevelled serrated edge below, for articulation with the malar bone. The base of the process is very broad antero-posteriorly, and is divided upon its under surface into two ridges called the *roots* of the zygoma, of which the *anterior* (5) is directed inward in front of the glenoid cavity, and the *posterior* backward to form the superior and anterior margins of the external auditory meatus. At the point of union between the two

roots is a small tubercle (3) for the attachment of the lateral ligament of the temporo-maxillary articulation. The *glenoid cavity* is the smooth, transversely oval fossa situated between the two roots of the zygoma, and in front of the auditory canal; it is divided by a transverse crack, called the *glenoid* or *Glasserian fissure* (6), into two unequal parts, of which the anterior and larger is smooth for articulation with the condyle of the lower jaw, and the posterior for the accommodation of a prolongation of the parotid gland.

The prolongation of the posterior root above the auditory foramen is frequently called the superior root, and that in front of this opening the middle root of the zygoma.

The *internal surface* of the squamous portion is concave, mammillated like the other bones of the cranium, and furrowed for the branches of the middle meningeal artery.

The *semicircular border* is sharp and bevelled off at the expense of the inner table, so as to overlap the corresponding part of the parietal and sphenoid bones.

The *mastoid part*, so called from its large nipple-like process, is situated posteriorly and inferiorly. The *external surface* is convex and rough, and terminated below in the beforementioned mastoid process, upon the inner side of which is a deep groove, called the *digastric fossa* (Fig. 75, 12), which gives attachment to the digastric muscle. Behind the process, and near the posterior border of the bone, is frequently a small opening (the *mastoid foramen*, Fig. 73, 8),

Fig. 73.

The external surface of the temporal bone of the left side. 1. The squamous part. 2. The mastoid part. 3. The extremity of the petrous part. 4. The zygoma. 5. Indicates the tubercle of the zygoma, and at the same time its anterior root turning inwards to form the articular eminence. 6. The superior root of the zygoma, forming the posterior part of the temporal ridge. 7. The middle root of the zygoma, terminating abruptly at the glenoid fissure. 8. The mastoid foramen. 9. The external auditory meatus. 10. The digastric fossa, situated immediately to the inner side of (2) the mastoid process. 11. The styloid process. 12. The vaginal process. 13. The glenoid or Glasserian fissure; the leading line from this number crosses the rough posterior portion of the glenoid fossa. 14. The opening and part of the groove for the Eustachian tube.

for the transmission of a vein. The *internal surface* is comparatively small, and almost entirely occupied by a broad deep groove, directed from above downward and forward for the lodgement of the lateral sinus. The *border* is irregularly convex, thick, and serrated, and articulates with the occipital bone.

Fig. 74.

The left temporal bone, seen from within. 1. The squamous part. 2. The mastoid part. The number is placed immediately above the inner opening of the mastoid foramen. 3. The petrous part. 4. The groove for the posterior branch of the middle meningeal artery. 5. The bevelled edge of the squamous border of the bone. 6. The zygoma. 7. The digastric fossa immediately internal to the mastoid process. 8. The occipital border. 9. The groove for the lateral sinus. 10. The elevation upon the anterior surface of the petrous bone marking the situation of the perpendicular semicircular canal. 11. The internal opening of the carotid canal. 12. The internal auditory meatus. 13. A dotted line leads upwards from this number to the narrow fissure which lodges a process of the dura mater. Another line leads downwards to the sharp edge which conceals the opening of the aqueduct of the cochlea, while the number itself is situated on the bony lamina which overlies the opening of the aqueduct of the vestibule. 14. The styloid process. 15. The stylo-mastoid foramen. 16. The carotid foramen. 17. The jugular process. The deep excavation to the left of this process forms part of the jugular fossa, and that to the right is the groove for the ninth, tenth, and eleventh pairs of nerves. 18. The notch for the fifth nerve upon the upper border of the petrous bone, near its apex. 19. The extremity of the petrous bone.

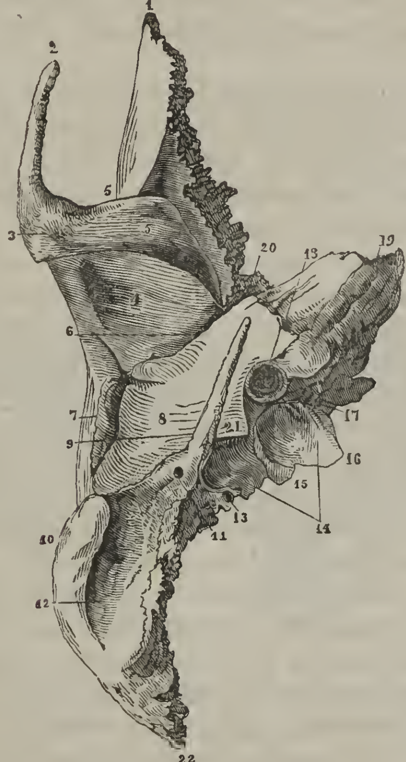
The *petrous part* is situated between and upon the inner side of the squamous and mastoid divisions, projecting inward and forward into the base of the cranium. It is triangularly pyramidal in shape, and presents, therefore, a base, an apex, three surfaces, and three borders.

The *base* is directed externally, and is continuous with the squamous and mastoid divisions. About its middle is a large circular opening called the *external auditory meatus*, or the entrance to the auditory canal, bounded above by the posterior root of the zygoma, and below and in front by a curved bony lamella called the *auditory process*, which forms also the posterior wall of the glenoid fossa. The margins of the opening are rough, for the attachment of the cartilage of the ear; and the canal, which is somewhat constricted at its middle, leads obliquely inward and forward to the tympanum.

The *apex* is irregularly truncated and almost entirely occupied by a large circular foramen, which is the internal extremity of the carotid canal.

The *anterior surface* looks upward as well as forward. It presents, near the superior border, a slight elevation corresponding to the semicircular canals contained within the bone, and, *below*, a small

Fig. 75.



Basal view of the petrous bone. 1. Anterior angle of squamous part. 2. Zygomatic process. 3. Tubercle. 4. Glenoid cavity. 5. *. 6. Fissure of Glasser. 7. *. 8. Plane surface for lodging part of the parotid gland. 9. Styloid process. 10. Mastoid process. 11. Stylo-mastoid foramen. 12. Digastric groove. 13. Tympanic foramen. 14. Jugular fossa. 15. Jugular ridge. 16. Jugular process or spine. 17. Aqueduct of the cochlea. 18. Basal orifice of the carotid canal. 19. Terminal orifice of the carotid canal. 20. Bony orifice of the Eustachian tube. 21. Vaginal process. (Morton.)

groove leading obliquely backward and outward to a minute foramen called the *hiatus* (hiatus Fallopii). The groove lodges the cranial branch of the Vidian nerve, which is transmitted through the hiatus to a canal named the *aqueduct* of Fallopius.

The *posterior surface* looks backward and a little upward, and presents near its centre a large opening called the *internal auditory meatus*, which is the entrance to the *internal auditory canal.* This canal is very short, and at its bottom in front a small cribriform or sieve-like plate may be observed, separated by a little crest of bone from the orifice of the aqueduct of Fallopius, which is behind. The canal receives the facial and the auditory nerve, the former of which enters the aqueduct, while the latter passes through the perforated plate to reach the internal ear. Behind and above the meatus is a small fissure-like opening named the *aqueduct of the vestibule.*

The *inferior surface* is rough and uneven, and presents the following objects worthy of notice: 1. The *styloid process*, a narrow stem of bone, an inch or an inch and a half in length, standing downward, forward, and inward from near the middle of the surface, to give attachment to three small muscles and the stylo-hyoid ligament. 2. A small opening called the *stylo-mastoid foramen*, which is situated between the styloid and mastoid processes, and gives passage to the facial nerve. 3. A prominent vertical crest or ridge improperly called the *vaginal process*, situated just in front of the styloid process, and extending from the root of the mastoid process behind the glenoid cavity toward the apex of the bone. 4. Behind the vertical crest a large, deep, smooth excavation called the *jugular fossa.* 5. The inferior orifice of the carotid canal, which, followed up, will be found to pass at first vertically and then horizontally inward to terminate upon the apex of the bone.

The *superior border* is traversed by a small longitudinal groove for the superior petrosal sinus, and toward its outer third by a slight prominence corresponding to the semicircular canals. The very short *anterior border* unites with the inferior edge of the squamous portion to form a retreating angle, at the bottom of which may be seen the orifices of two canals, placed one above the other, the inferior and larger constituting the bony part of the Eustachian tube, the superior lodging one of the muscles of the tympanum. The *posterior* is rough, and notched near its middle by the jugular fossa, which is sometimes divided into two unequal portions by a spicula of bone (jugular spine), thus forming with the inferior border of the occipital bone two foramina, of which the anterior and smaller transmits the eighth pair of nerves, and the posterior, the jugular vein.

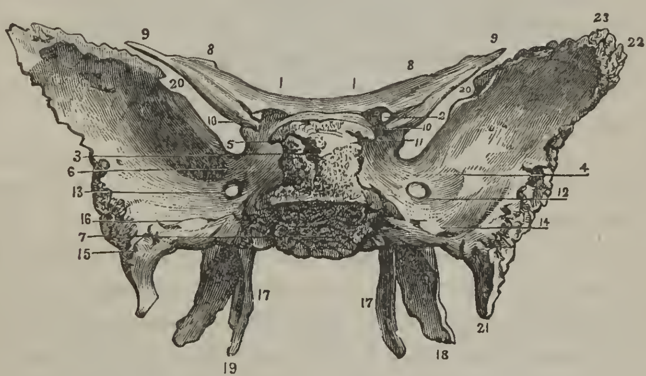
The temporal bone joins the parietal, malar, sphenoid, occipital, and inferior maxillary bones.

THE SPHENOID BONE.

The sphenoid* bone occupies the middle of the base of the cranium, and has been compared in shape to a bat with extended wings. It is symmetrical, and consists of a body or central part of six processes, three on each side, named, respectively, the great and small wings, and the pterygoid processes.

The *body* is irregularly cuboidal, and has, therefore, six surfaces. The *superior surface* is hollowed out into a smooth shallow fossa, called the *pituitary fossa* (sella Tunica), bounded *behind* by a quadrilateral thin plate of bone projecting obliquely forward and upward, presenting posteriorly a smooth surface called the *clivus*, and terminating in two tuberculated corners denominated the *posterior clinoid*

Fig. 76.



Posterior view of the sphenoid bone. 1, 8, 9. Lesser wings. 2. Optic foramen. 3. Clivus. 4, 6. Concavity of greater wings, for lodging the middle lobe of the brain. 5, 11. Posterior clinoid processes. 7. Basilar or cuneiform suture. 10. Anterior clinoid process. 12, 13. Round foramen. 14, 16. Oval foramen. 15. Spinous foramen. 17, 17. Internal pterygoid process. 18. External pterygoid process. 19. Trochlea of the internal pterygoid process. 20, 20. Sphenoidal fissure. 21, 22. Suture for the squamous portion of the temporal bone. 23. Suture for the frontal bone.

processes; laterally, by a superficial longitudinal furrow corresponding to the internal *carotid artery*, and, hence, named the carotid groove ; and, *in front*, by a small eminence named the *olivary process*, supporting a curved furrow that leads outward and forward to the *optic foramina*. The furrow corresponds to the optic commissure, and the foramina (one on each side) are large, transversely oval,

* σφην, a wedge.

and directed forward and a little outward, and transmit the optic nerves and opthalmic arteries. Behind and external to the optic openings are the *anterior clinoid processes*, two thick tubercles forming the posterior angles of the lesser wings; they are, sometimes, found united to the posterior clinoid processes by a delicate bony arch, and often to the body of the bone upon the inner side of the carotid groove, so as to form this groove into a foramen at this point. In front of the olivary process this surface, which is here elevated above the fossa, is continued horizontally forward to join the ethmoid bone, and presents in the median line a slight antero-posterior ridge separating two very superficial excavations corresponding to the olfactory nerves. Standing horizontally outward from the sides of this portion of the surface are the *lesser wings* or apophyses of Ingrassius. These are two triangular thin plates, each presenting two surfaces, a superior or cerebral, and an inferior or orbital; three borders, viz.: an anterior, sharp and serrated, for articulation with the orbital plates of the frontal bone; an internal, by which it is attached to the body of the bone, and an external, thick and rounded, which overhangs the sphenoidal fissure; also two angles, an external, sharp and pointed, and a posterior, forming the anterior clinoid process already mentioned.

The *anterior surface* forms the posterior wall of the nasal cavities, and presents in the middle line a prominent vertical crest or rostrum, called the *azygos process*, separating the large orifices of the two *sphenoidal cells* or cavities into which the body of the bone of the adult subject is hollowed. These cavities are wanting in childhood, but are gradually developed as adult life advances, and, in old persons, often occupy the whole body of the bone; they are separated from each other by a thin bony septum, and are covered in anteriorly by the pyramidal processes of the ethmoid bone, which, in early life, are distinct and separable from the sphenoid bone, but become ultimately blended with it and assist in forming the cells.

The *inferior surface* is included between the pterygoid processes, and is marked in the median line by a continuation of the rostrum, which projects from the middle of the anterior surface. Upon each side of the rostrum is a slight antero-posterior fissure or groove, formed by a little shelving lamella of bone projecting from the root of the pterygoid process downward and inward toward the median line, and intended for the reception of the flaring edge of the vomer. Immediately external to this is a small furrow which forms a part of the *pterygo-palatine canal.*

The *posterior surface* is quadrangular and rough, for articulation with the basilar process of the occipital bone.

The *lateral surfaces* are occupied entirely by the roots of the greater wings and pterygoid processes.

The *greater wings*, the largest of the three processes, stand outward from the sides of the body of the bone, and are very irregular in shape; they have each three surfaces and as many corresponding borders. The *superior surface* is concave, elongated from behind forward and outward, and constitutes the greater part of the middle fossa of the floor of the cranium. The *anterior* looks inward and forward, is quadrilateral and smooth, and forms the

Fig. 77.

Anterior view of the sphenoid bone. 1, 2. Azygos process or rostrum. 3. Sphenoidal cells. 5, 9. Vidian or pterygoid foramen. 6, 6. Internal pterygoid process. 7. External pterygoid process. 8. Hamulus, or trochlea of the internal pterygoid process. 10. Suture for the frontal bone. 11, 15. Lesser wings. 14. Suture for the squamous part of the temporal bone. 16, 17. Optic foramina—these two figures mark the sphenoidal fissure of each side. 18. Round foramen. 19. The external or surface of the greater wing.

greater part of the external wall of the orbit. The *external*, the most extensive of the three, is quadrilateral, elongated from above downward, backward, and inward, and is divided by a transverse ridge into two unequal parts, the anterior and larger of which is concave and enters into the formation of the temporal fossa; the posterior, also slightly excavated, constitutes the superior part of the zygomatic fossa, and is rough, for the attachment of the external pterygoid muscle. The *anterior border*, directed obliquely downward and backward, separates the temporal and orbital surfaces, and unites with the orbital process of the malar bone; the *external* divides the temporal and cerebral surfaces, is concave, bevelled externally, and

somewhat serrated for articulation with the squamous portion of the temporal bone; the *internal* joins the body of the bone in the middle, is free, and forms the outer margin of the sphenoidal fissure in front, and curves outward behind, where it is in contact with the anterior margin of the petrous bone. The *angle* formed by the three borders in front is truncated; it presents upward and forward, and is triangular in shape, and very uneven, for union with the lower external edge of the frontal bone; that formed behind, by the external and internal, occupies the receding angle between the squamous and petrous divisions of the temporal bone, and presents underneath a small pointed prominence called the spinous process.

The *pterygoid processes*, representing the legs of the bat, originate from the sides of the body in common with the greater wings, and are directed almost vertically downward. Each one consists of two bony laminæ, which are united by their anterior margins to within a short distance of their lower extremities, but diverge behind to form a large deep groove called the *pterygoid fossa.* The external plate is broad and flaring, and forms, by its outer surface, the vertical portion of the zygomatic fossa; the internal, long and narrow, terminates below in a little hook-like or *hamular process*, for the reflection of the tendon of the circumflex palate muscle, which originates from a little superficial excavation called the *scaphoid fossa*, situated upon the posterior aspect of the root of this plate. The notch formed by the separation of the anterior margins of the two plates below is filled up by the palate bone, which completes the pterygoid fossa in this situation.

Foramina.—Each lateral half of the sphenoid bone presents five foramina and a canal. The largest of these openings is the anterior lacerate foramen (foramen lacerum anterius), or more properly the *sphenoidal fissure;* it is situated between the greater and lesser wings, is triangular in shape, and gives passage to the third, fourth, first branch of the fifth, and the sixth nerves, and ophthalmic vein. Immediately above and internal to this is the *optic foramen.* Just below and near the body of the bone is the *round opening* (foramen rotundum), somewhat smaller than the optic, directed forward and outward, and occupied by the second branch of the fifth pair of nerves. Behind this last, and a little removed outward, is a large *oval opening*, through which the third branch of the fifth pair passes to the lower jaw. The last and least is the *spinous foramen*, situated near the process of the same name, and just without the preceding; it transmits the middle artery of the dura mater. The canal, called the

pterygoid or *Vidian*, is situated at the base of the pterygoid process, extending horizontally from before backward ; its anterior orifice is quite large and distinct, but its posterior is small; it gives passage to the Vidian nerve.

The sphenoid articulates with all the bones of the cranium, and with the palate, vomer, and malar bones of the face.

THE ETHMOID* BONE.

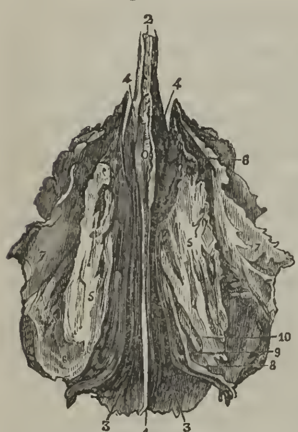
The ethmoid bone, so called from its cribriform or sieve-like appearance, is situated in the middle of the anterior part of the base of the skull, in front of the sphenoid, and between the orbital plates of the frontal bone. It is remarkable for its light cellular character, being composed of thin bony laminæ, inclosing numerous large cells which communicate freely with each other and with the cavity of the nose. It consists of a vertical and a horizontal or cribriform plate, and two lateral masses.

The *vertical plate* (seen by removing one of the lateral masses) is situated in the middle line of the skull, forms a large part of the bony septum that separates the two nasal cavities, and projects into the cavity of the cranium in the form of a triangular-shaped crest. The *nasal* portion (nasal lamella) is broad and quadrilateral, often deviates a little from the middle line to one side or the other, is marked upon both surfaces by numerous small vascular grooves; it articulates by its anterior margin with the nasal spine of the frontal bone, by its inferior, with the vomer and triangular cartilage of the nose, and by its posterior, with the rostrum of the sphenoid bone. The *cerebral* portion of the vertical plate, commonly called the *crest*, or, more technically, the crista galli, is situated in the middle of the upper surface of the cribriform plate from which it rises, as it were, from behind forward, and attains an elevation in front of a quarter or third of an inch ; its superior border gives attachment to the anterior extremity of the falciform process of the dura mater; its anterior edge separates into two narrow lamellæ, that form with the lower extremity of the ridge, upon the middle of the inner surface of the frontal bone, a small canal (foramen cœcum), for the transmission of a small vein to the longitudinal sinus, and the lodgement of a small process of the dura mater.

* ηθμος, a sieve.

The *horizontal* or *cribriform plate* is quadrangular; it occupies the notch between the orbital portions of the frontal bone, and thus forms a part of the floor of the cranial cavity, and a part of the roof of nasal fossa. It is divided into two lateral halves by the crest, and perforated, as its name (cribriform) indicates, by numerous foramina which transmit the branches of the olfactory nerves. Two of these openings, somewhat larger than the others, and situated close to the crest, one on each side, give passage to the nasal twigs of the ophthalmic nerves. Its superior or cerebral surface is slightly excavated on each side of the crest, and supports the bulbs of the olfactory nerves; its inferior is covered by the mucous membrane of the nose. Its lateral and anterior borders join the orbital plates of the frontal bone, and its posterior, the anterior edge of the lesser wings of the sphenoid bone.

Fig. 78.



View of the ethmoid bone from below. 1. Posterior end of the nasal lamella. 2. Its anterior extremity. 3, 3. Posterior margins of the cribriform plate, and the fissure, on each side, separating the nasal lamella from the lateral spongy portions of the bone. 4, 4. Anterior portions of the same fissures. 5, 5. Middle spongy or turbinated bones. 6. Upper meatus of the nose. 7. Curved lamellæ or scrolls of bone that bound the upper meatus above. 8, 9. Posterior opening of the upper meatus. 10. Point at which the superior meatus communicates with the posterior ethmoidal cells. The rough projection between 3 and 8 is the pedicle from which the pyramidal process has been detached; the same is seen on the opposite side external to the figure 3.

The *lateral parts* of the bone are quadrangular, and about half an inch thick; they hang vertically from the under surface of the cribriform plate, and form part of the outer walls of the nasal fossæ and inner walls of the orbital cavities. They each present, therefore, two surfaces and four borders. The *external surface*, called, sometimes, the orbital plate, is smooth and quadrangular, parallel with its fellow of the opposite side, and forms by far the greater part of the inner wall of the corresponding orbit. The *internal* or *nasal surface* is rough and uneven, and partially traversed by an antero-posterior groove, called the superior meatus of the nose, which does not reach as far forward as the anterior border of the bone. Above and below this groove is a thin bony lamina, each rolled, as it were, upon itself, directed obliquely from before backward and downward, and named, in connection with the nasal cavities, the *superior* and *middle turbinate* bones. (See *Nasal Cavities.*) The *superior border* is partly connected to the under surface of the

cribriform plate, externally to which it projects for articulation with the orbital plate of the frontal bone, and presents a number of half cells and two small notches; the latter form, when the bones are joined together, the anterior and posterior internal orbital foramina. The *anterior* and *inferior borders* are also cellular; the former articulates with the unguiform or lachrymal bone, the latter joins the superior maxillary bone and overhangs the middle groove or meatus of the nose. *Posteriorly*, the lateral masses are prolonged into two peduncular, hollow, triangular pyramidal processes, resting against the anterior surface of the body of the sphenoid bone, and separated by the rostrum. In the young adult, the cavity which each pyramidal process contains opens into the nasal cavity, but in the course of time these processes become blended with the sphenoid, and their cavities go to form part of the cells of this bone.

The lateral parts of the ethmoid are cellular throughout. The cells are of various shapes and sizes; many of them are quite large, separated from each other by thin bony laminæ, and lined in the recent state by a continuation of the nasal mucous membrane. They constitute a part of the olfactory apparatus and are divided into two sets, an anterior and a posterior; the former, larger and more numerous, communicate above with the frontal sinuses, and below by a funnel-shaped passage (infundibulum) with the anterior extremity of the middle groove or meatus of the nose. The posterior set open into the superior nasal groove.

The ethmoid bone articulates with two bones of the cranium, namely, the frontal and sphenoid, and with eleven of the face, namely, the vomer in the middle line, and on each side the unguiform, superior maxillary, inferior turbinate, nasal, and palate bones.

THE BONES OF THE FACE: SUPERIOR MAXILLARY.

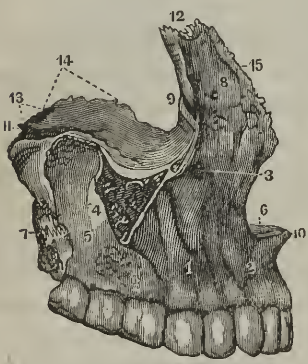
The face is situated below and in front of the cranium, and consists of fourteen separate bones, of which two, the vomer and inferior maxilla, are median or symmetrical, and the others are in pairs; they are the superior maxillary, malar, palate, nasal, unguiform, and inferior turbinate bones.

The superior maxillary bone is the basis or fundamental piece of the upper jaw, and forms the greater part of the front of the face. Although very irregular in shape, it is considered as having an external, an internal, a superior, and an inferior surface, and four borders.

The *external* or *cutaneous surface* is convex, and presents in front two superficial excavations; one is very small, situated just above the incisor teeth, and called the *myrtiform* or *incisive fossa*; the other is larger, and named, from its position between the canine tooth and margin of the orbit, the *infra-orbital* or *canine fossa.* In the upper part of the latter is the *infra-orbital foramen*, the outlet of the small canal of the same name. External to the canine fossa is a vertical ridge, behind which the bone is swollen out into what is called the *maxillary tuberosity.*

The *superior* or *orbital surface* is smooth and triangular, inclined downward and outward, and constitutes nearly the whole of the floor of the orbit. It is traversed from behind by a small groove leading to the *infra-orbital canal*, which opens in the canine fossa and transmits the cutaneous division of the second branch of the fifth nerve and a small artery. The internal edge of this surface joins the unguiform bone and orbital plate of the ethmoid. The external is rounded and assists in forming the *spheno-maxillary fissure;* the anterior constitutes the anterior inferior margin of the orbit. Of its three angles, the external forms a rough eminence called the *malar process*, the triangular surface of which is serrated for articulation with the malar bone; the posterior is cut off, as it were, for union with the small orbital process of the palate bone; the internal or anterior rises in the form of a long process, the *ascending* or *nasal process*, which is flattened from side to side, broad below, narrow above, slightly twisted upon itself, and grooved upon its outer posterior aspect for the nasal duct. This process forms the internal margin of the orbit, and articulates above by a narrow serrated extremity with the frontal bone, in front with the nasal bone, behind with the unguiform, and internally, by means of two corresponding horizontal ridges, with the middle and inferior turbinate bones.

Fig. 79.



External view of the superior maxillary bone. 1. The canine fossa. 2. Myrtiform fossa. 3. Infra-orbital foramen. 4. Malar process. 5. Maxillary tuberosity. 6. Floor of the nose. 7. Suture for the sphenoid bone. 8. Nasal process. 9. Curved space for the unguiform bone. 10. Nasal spine. 11. Posterior orifice of the infra-orbital canal. 12. Summit of the nasal process, which articulates with the frontal bone. 13. Posterior margin of the orbital plate, which joins the orbital process of the palate bone. 14. Margin of the orbital plate that joins the ethmoid bone. 15. Anterior edge of the nasal process, which articulates with the nasal bone.

The *internal surface* constitutes the external wall of the nasal cavity, and is marked—1, by two transverse ridges for articulation with the middle and inferior turbinate bones, continuous with those upon the nasal process; 2, in front, by the vertical groove for the nasal duct; and 3, about its centre, by the opening of the maxillary sinus or antrum. In the detached bone this opening is large and triangular, but when the ethmoid, unguiform, palate, and inferior turbinate bones are in place, and covered by the mucous membrane of the nose, it is not larger than an ordinary crow-quill. The *palate process* projects from this surface below, and extends nearly its whole length antero-posteriorly. It is a horizontal quadrangular plate of bone forming the floor of the nostril and the roof of the mouth; its superior or nasal surface is smooth and concave from side to side; its inferior, also concave, is rough, for the attachment of the lining membrane of the mouth, and perforated by numerous vascular foramina; its internal edge is thick and serrated for articulation with its fellow of the opposite bone, with which it forms, in the median line superiorly, a low ridge for union with the vomer, terminating in front in a small prolongation called the *nasal spine*. Upon each side of this median ridge anteriorly is a small foramen, named the *incisor foramen*, leading to the *anterior palatine canal*, which opens upon the roof of the mouth by a common orifice with its fellow of the opposite bone. The posterior margin is thin, being cut away above for articulation with the palate process of the palate bone.

The *anterior border* of the body of the bone is continuous with that of the nasal process, and curves outwardly to form one-half of the heart-shaped entrance to the nasal cavities. The *posterior* is rounded above where it forms part of the spheno-maxillary fissure, rough below, for articulation with the palate bone, and grooved in a vertical direction for the *posterior palatine canal*, which is situated between the two. The *anterior* or dental border is thick and strong, and presents eight conical cavities called *alveoli* for the lodgement of the teeth. These alveolar cavities or sockets are separated from each other by their bony laminæ, are larger behind than in front, and subdivided into as many smaller cavities as there are roots to the teeth which they receive.

The *maxillary sinus* or *antrum* is the large cavity occupying the body of the bone. It is triangularly pyramidal in shape, its base presents internally, and its apex at the malar process. Its superior wall is formed by the orbital plate, the posterior by the tuberosity, and the anterior by the facial portion of the bone; the two latter are

marked by numerous grooves for the dental branches of the infra-orbital nerve. The bony septum between this cavity and the alveoli of the molar teeth is very thin, a fact that is frequently turned to advantage when it becomes necessary to open the antrum for the discharge of purulent accumulations. In the recent state, the antrum is lined by mucous membrane, and communicates with the middle meatus of the nose.

The superior maxilla articulates with two of the cranial bones, the frontal and ethmoid, and with seven of the face, namely, the nasal, unguiform, malar, palate, inferior turbinate, vomer, and its fellow of the opposite side.

THE PALATE BONE.

The palate bone is situated upon the inner side of the posterior border of the superior maxillary bone, and in front of the pterygoid process of the sphenoid. It consists of an horizontal and a vertical plate, the latter terminating above in two small processes called the sphenoidal and orbital.

Fig. 80.

The right palate bone viewed from in front. 1, 3. Palate process. 2. Palate ridge, terminated behind by the palate spine. 4, 5. Pterygoid process. 4. Groove for the internal pterygoid process of the sphenoid bone. 5. Groove continuous with the pterygoid process of the sphenoid. 6. Ridge for the lower spongy bone. 7. Pterygoid apophysis. 8. Orbital plate. 9. Spheno-palatine foramen.

The *horizontal plate*, called also the palate process, is quadrilateral, and forms the posterior part of the hard or bony palate. Its *superior* or *nasal surface* is smooth and slightly excavated transversely; the *inferior* is rough for the attachment of the mucous membrane of the mouth and the tensor muscle of the palate. Its *anterior border* is thin and rests upon the posterior margin of the palate process of the superior maxillary bone; the *posterior* is free, but concave and sharp, and gives attachment to the soft palate; the *internal* is thick and serrated for articulation with the opposite bone, with which it forms a median ridge above for articulation with the vomer, terminating posteriorly in a small sharp process called the *posterior nasal spine;* the *external* is continuous with the inner surface of the vertical plate at a right angle.

The *vertical* or *nasal plate* is very thin, broad, and quadrangular. Its *internal surface* forms the posterior

part of the external wall of the nasal fossa, and is traversed by two horizontal ridges for the attachment of the inferior and middle turbinate or spongy bones; between the two, and below the inferior, the surface is somewhat concave, corresponding to the middle and the inferior meatus of the nose. The *external surface* is applied to the inner face of the superior maxillary behind, and assists in closing the antrum. It is traversed by a vertical groove that forms with the last-mentioned bone the whole extent of the *posterior palatine canal.* A very small part of this surface enters also into the floor of the zygomatic fossa, between the maxillary tuberosity and pterygoid process of the sphenoid bone. The *anterior margin* is thin, and forms the posterior boundary of the orifice of the maxillary antrum; the *posterior* is rough, joins the pterygoid process, and terminates below in a thick, triangular pyramidal enlargement, directed downward, backward, and outward, and presenting upon its posterior upper surface three vertical grooves, two for the reception of the anterior edges of the pterygoid plates, and the other, the middle one, for the completion of the pterygoid fossa below. The *inferior* is continuous with the palate plate, and connects the posterior extremity of the alveolar margin of the superior maxilla with the pterygoid process. The *superior*, also thin, presents a deep notch which forms the greater part of the *spheno-palatine foramen*, and separates the two small processes which belong to this part of the bone. The *sphenoidal process*, the posterior and smaller of the two, is rather thin, broad, bent inward toward the median line; it may be considered as having three surfaces, one corresponding to the nasal fossa; another, the external, to the zygomatic fossa; and a third, or superior, that articulates with the body of the sphenoid, and forms with it a part of the pterygo-palatine canal. The *orbital process*, situated anterior to the notch and connected to the vertical plate by a thin narrow pedicle, inclines a little outward, and, when in position, appears in the extreme back part of the floor of the orbit. In a well-developed bone this process presents three articulating surfaces, which unite with the corresponding portions of the superior maxillary, ethmoid, and sphenoid bones; and two non-articular, one forming part of the zygomatic fossa, and the other the posterior angle of the floor of the orbit. The surface corresponding with the sphenoid bone is often hollowed out into a half cell, which communicates with or rather constitutes a part of the sphenoidal cells.

The palate bone articulates with the superior maxillary, sphenoid,

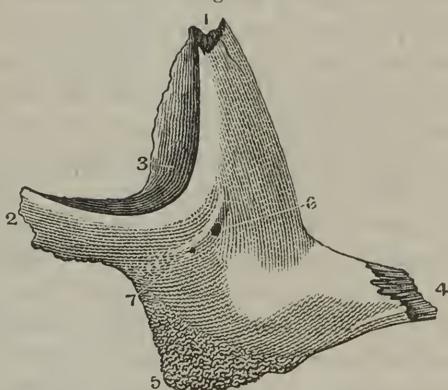
ethmoid, vomer, and inferior turbinate bones, and with its fellow of the opposite side.

THE MALAR BONE.

The malar bone is situated at the upper and outer part of the face, where it forms the prominence of the cheek. It is irregularly quadrangular in shape, and very strong and compact; it has three surfaces, four borders, and four angles.

The *external* or *cutaneous surface* is convex and smooth, and perforated by numerous holes for the transmission of small nerves and vessels; the *posterior*, or *temporal*, is concave, and forms a part of the temporal fossa; the *superior*, or *orbital*, forms the outer lower wall of the orbit; it is semilunar, smooth, and concave, perforated at one or

Fig. 81.



The malar bone of the left side. 1. Superior orbital or frontal process. 2. Inferior orbital process. 3. Orbital plate, or internal orbital process. 4. Zygomatic process. 5. Maxillary process. 6 Foramen for the temporo-malar nerve. 7. Foramen for an arterial twig.

two points to give passage to small nerves, and contributes by its lower border to the formation of the spheno-maxillary fissure.

The *superior border* forms the external third of the edge of the orbit, and is consequently concave and blunt; the *posterior* is thin, and curved somewhat like the letter S, and gives attachment to the temporal aponeurosis; the *inferior* is continuous with the lower margin of the zygoma; and the *anterior* is rough for articulation with the superior maxilla.

The *anterior angle* is long and pointed, and rests upon the superior

maxilla ; the *posterior* is broad, thin, bevelled at the expense of the upper surface, and serrated for articulation with the zygomatic process of the temporal bone; the *superior* is thick and rough, and supports the external angular process of the frontal bone; the *inferior* is obtuse, looks downward and backward, and joins the outer part of the rough surface on the superior maxilla.

The malar bone articulates with the frontal, sphenoid, temporal, and superior maxillary bones.

THE NASAL BONES.

The nasal bones form what is commonly called the bridge of the nose. They are small and quadrangular, thick and narrow above, broad and expanded below, and present an anterior, smooth, convex, cutaneous surface, and a posterior that is concave and furrowed for the lodgement of nerves and vessels. The *superior* margin is narrow, but thick and deeply serrated for articulation with the frontal bone; the *external* is grooved where it rests upon the anterior edge of the nasal process of the superior maxilla ; the *internal* is quite thick, rough, for articulation with its fellow, and, when the two bones are in place, forms a ridge upon the under surface, where the two rest upon the nasal spine and perpendicular plate of the ethmoid; the *inferior* is thin and sinuous, and gives attachment to the cartilage of the nose.

Each nasal bone is articulated with the frontal, superior maxillary, and ethmoid bones, and with its opposite fellow.

THE UNGUIFORM OR LACHRYMAL BONES.

The unguiform bones, so called from their resemblance to a finger-nail (*unguis*, a nail), are the smallest bones of the face, and are situated at the internal lateral part of the orbit, below the frontal bone, and between the nasal process of the superior maxilla and the orbital plate of the ethmoid. They are quite thin and quadrangular, and present two surfaces and four borders. The *external* or *orbital surface* is divided by a vertical ridge into two parts, the anterior of which is grooved for the commencement of the nasal duct, while the posterior is plain and smooth, and completes the inner wall of the orbit. The *internal* or *ethmoidal surface* is grooved opposite the external ridge, covers some of the cells of the ethmoid behind, and forms a part of the middle meatus of the nose in front.

The lachrymal bone articulates by its superior border with the frontal bone, posteriorly with the ethmoid, inferiorly with the superior maxilla and inferior turbinate, and anteriorly with the nasal process of the superior maxilla.

THE INFERIOR TURBINATE OR SPONGY BONES.

The inferior turbinate bones,* of which there is one in each nasal fossa, are thin elongated bony plates curved upon themselves transversely, and attached by one margin to the ridge upon the inner surface of the superior maxillary and palate bones. The inner surface of each is convex, and looks towards the median line; the outer is concave, and presents toward the external wall of the nasal fossa; both are rough and spongy, and, in the recent state, covered by the lining membrane of the nose. The inferior edge is free and turned upward; the superior, as before stated, is attached along the lower horizontal ridge upon the outer wall of the nasal fossa, and is remarkable for a small vertical prolongation called the *nasal unciform*, or *lachrymal process*, which forms the inner wall of the nasal duct, and articulates above with the lachrymal bone.

Fig. 82.

External view of the right inferior turbinate bone. 1. Anterior extremity. 2. Posterior extremity. 3. Unciform process. 4. Inferior border. (Smith and Horner.)

The inferior turbinate bone differs from all the others in having its cellular or spongy tissue on the surface, inclosing the compact substance. It separates the inferior and middle meatuses of the nose, assists in closing the maxillary antrum, and articulates with the superior maxillary, palate, and lachrymal bones.

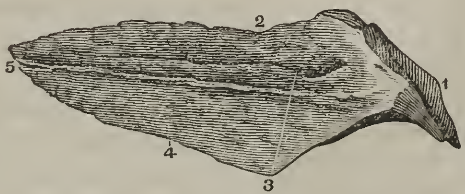
THE VOMER.

The vomer is a thin, flat, and quadrilateral bone, situated in the median line between the nasal fossæ, and directed obliquely from above downward and forward, frequently, however, inclining to one

* Called *turbinate* on account of their rolled up appearance, and *inferior* to distinguish them from the middle and superior, which are divisions of the ethmoid.

or the other side. Its two surfaces are smooth, but marked by numerous small furrows for the reception of nervous and vascular twigs. Of its four margins, the *superior* is short and thick, and divided into two lateral flaring lips, which are separated by an antero-posterior groove; the former is received by the groove upon each

Fig. 83



Lateral view of the vomer. 1. Superior grooved margin, for articulation with the azygos process of the sphenoid. 2. Anterior margin, continuous with the nasal lamella. 3. Grooves for the anterior palatine nerves. 4. Inferior margin, to join the intermaxillary ridge. 5. Anterior angle.

side of the under surface of the body of the sphenoid, and the latter embraces the inferior edge of the rostrum. The *inferior* margin is long and thin, and is received into the furrow upon the nasal crest of the superior maxillary and palate bones; the *anterior* is slightly grooved for the triangular cartilage that completes the nasal septum in front; the *posterior* is thin, sharp, and unattached.

The vomer articulates with the sphenoid, ethmoid, superior maxillary, and palate bones, and with the triangular cartilage of the septum.

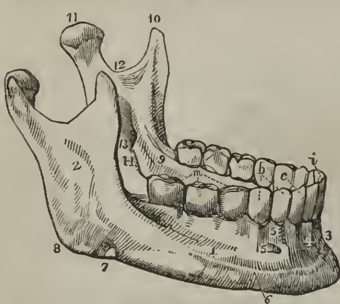
THE INFERIOR MAXILLARY BONE.

The inferior maxilla or lower jaw, the largest and the only movable bone of the skull, is situated at the lower part of the face, where it forms the peculiar and characteristic prominence known as the chin. It is shaped somewhat like a horseshoe with its extremities bent upward, and is considered, therefore, as consisting of a body and two rami or branches.

The *body* is flattened from without inward, and presents an external convex and an internal concave surface. The *external* or *cutaneous* surface is marked in the median line by a slight vertical ridge called the *symphysis*. This indicates the original development of the bone by two halves, which are separate in very young persons, and in many of the inferior animals united only by suture. Upon

each side of the upper half of the symphysis is a superficial depression called the *mental* or *incisor fossa*, upon whose outer side is the *mental foramen*, which lead to the dental canal, and is occupied by the cutaneous branches of the inferior dental nerve and a little artery. Below the fossa and foramen, the *external oblique ridge* commences, which extends backward and upward, becoming more and more prominent as far as the anterior margin of the ramus with which it is continuous. The *internal surface* has a vertical line in the situation of the symphysis, upon the lower part of which is a small, well-defined, bony prominence, called the *genial* or *mental process*, divided at its summit into four tubercles, two on each side, for the attachment of muscles. Corresponding to the external oblique ridge is the *internal*, called, also, the *milo-hyoid ridge*, and, above it, upon each side of the median line in front, there is a small shallow fossa corresponding to the sublingual gland. Below the ridge, and near the middle of each lateral half of the body, is a tolerably large well-marked excavation for the submaxillary gland, and a slight groove continued back to the middle of the ramus for the lodgement of the milo-hyoid nerve.

Fig. 84.



The lower jaw. 1. The body. 2. The ramus. 3. The symphysis. 4. The incisor fossa. 5. The mental foramen. 6. The external oblique line. 7. The groove for the facial artery; the situation of the groove is marked by a notch in the bone a little in front of the number. 8. The angle. 9. The extremity of the mylo-hyoidean ridge. 10. The coronoid process. 11. The condyle. 12. The sigmoid notch. 13. The inferior dental foramen. 14. The mylo-hyoidean groove. 15. The alveolar processes. *i*. The middle and lateral incisor teeth of one side. *t*. The canine tooth. *b*. The two bicuspids. *m*. The three molars.

The *superior* border is horizontal, and marked by the dental alveoli or sockets, which, like those in the upper jaw, are separated from each other by thin laminæ, and correspond in size and shape to the teeth which they lodge. The *inferior border* describes a larger curve than the superior, is also horizontal and thicker in front, where it is turned slightly forward to give prominence to the chin. It is marked near the commencement of the ramus by a slight notch or groove for the facial artery.

By means of the external and internal oblique ridges, the body of the inferior maxilla is divided into a superior or alveolar, and an inferior or basilar portion. Of these two, only the former is present in infants, and the latter in toothless old persons; while in the

adult the former constitutes about two-thirds of the depth of the bone.

The *rami* or branches are laterally flattened, and are much thinner than the body, quadrilateral, and nearly vertical. The *external surface* of each is plain above, but slightly everted, and marked by inequalities below, where it gives attachment to the masseter muscle. The *internal surface* is marked near its middle by the superior opening of the inferior dental canal, whose inner margin is elevated in the form of a small, vertical, flat spine, for the attachment of the internal lateral ligament of the temporo-maxillary articulation. Below the spine is the commencement of the milo-hyoid groove. The *anterior border*, thicker below than above, and slightly excavated or grooved, gives attachment to the buccinator muscle; the *posterior* is rounded, slightly ridged below, and almost entirely free; the *inferior* is continuous with the base of the bone, and forms with the preceding an angle, which in the young subject and in old toothless individuals is obtuse, but, in the middle-aged adult, nearly a right angle. The *superior* edge is sharp, and presents in the middle a semicircular or *sigmoid notch*, terminating in front in a laterally flattened, triangular pointed elevation called the *coronoid process*, and ending behind in a constricted process, or *neck*, flattened obliquely from before backward and surmounted by the articular eminence termed the *condyle*. The condyle is oblong, convex, and smooth when it is covered with cartilage; its greatest diameter is transverse, but inclined from without slightly backward, so that its axis, if prolonged inward, would pass immediately in front of the occipito-spinal foramen.

The inferior maxilla consists of two laminæ of compact substance inclosing an internal diploic or cellular tissue. The inferior dental canal traverses the latter, from above downward and forward; it transmits the dental vessels and nerves and communicates externally by the mental foramen.

The inferior maxilla articulates only with the temporal bone.

GENERAL CHARACTERS OF THE SKULL.

All of the bones of the skull except the lower jaw are joined together by immovable articulation, the opposed edges presenting, generally, a serrated or tooth-like arrangement by which they are dovetailed together. The lines formed by this union are called *sutures*, distinguished from each other by names derived from the bones be-

tween which they occur, as, for instance, the spheno-palatine, naso-frontal, &c. Those upon the cranium, however, are still frequently called by their old names; thus, the one between the frontal and parietal bones is called the *coronal*, that between the occipital and parietal, the *lambdoidal;* that between the two parietal connecting the coronal and lambdoidal in the middle line of the top of the head, the *sagittal*, and the one between the lower edge of the parietal and upper border of the temporal, the *squamous*.

The use of the sutures was, for a long time, a matter of dispute among anatomists, but it is now generally admitted that they are connected with the development of the skull, each individual bone increasing relatively to the others by a deposit of ossific matter upon its edges or circumference. Another important office, although in some measure accidental, is to allow the head of the fœtus to become moulded to the genital passages of the mother during parturition.

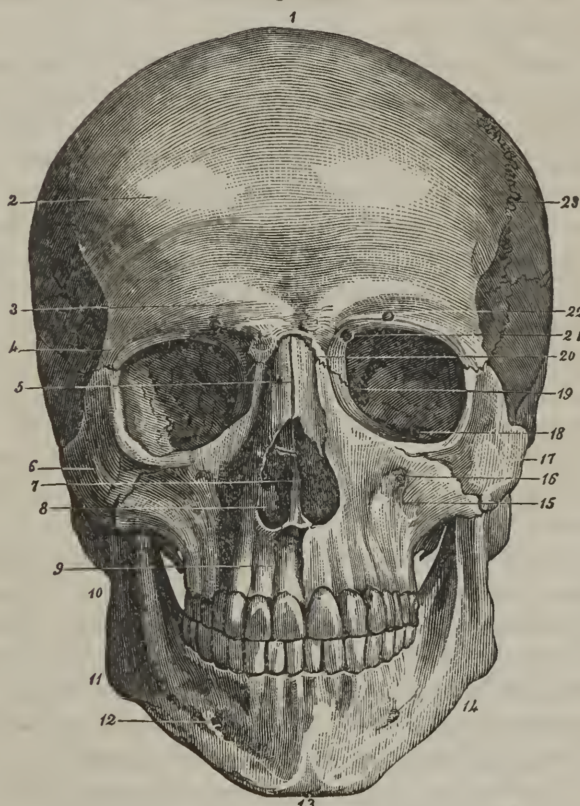
In illustration of the fact that the true use of the sutures is to allow the growth of the bones, there is, in the Museum of the University of Louisville, the skull of a young man, an idiot, that answers very nearly to the description of one in the possession of the late Dr. Morton, of Philadelphia, in which the sagittal, squamous, and coronal sutures are consolidated, and the cranium developed consequently only in the direction of the occiput. Whether the idiocy depended upon the same cause is a question.

The form of the head is an irregular oval, flattened laterally and below, and presents for consideration externally an anterior, two lateral, an inferior, and a superior surface or region.

1. The *anterior* or *facial region* is oval in shape, and may be marked off *above* by the frontal protuberances, below by the chin, and, upon each side, by the cheek-bone and the external oblique ridge of the lower jaw. The superior part of this region constituting what is commonly known as the forehead, is convex, and divided into two lateral halves by a median line, or sometimes a suture, upon each side of which above are the *frontal protuberances*, and, at its lower termination, the *nasal protuberance*, or *boss*, with the *superciliary arches* turning outwards. The *nose* is immediately below the boss, and joined to it by a short transverse suture. It is formed by two small oblong bones joined together in the median line, and supported upon each side by the ascending process of the superior maxilla. At the sides of the nose, and below the superciliary arches, are the large quadrangular openings of the orbits, below which, upon each side, is the

canine, or *maxillary fossa*, with the *infra-orbital foramen*. External to the orbits are the prominences of the *cheek-bones*, upon which may be seen one or more small foramina for the transmission of nervous filaments and vascular twigs. Beneath the bridge of the nose, and between the canine fossæ, is the large entrance to the nasal cavities, shaped like an inverted heart on playing-cards, and divided at its

Fig. 85.



Front view of the head and face. 1. Frontal bone. 2. Frontal protuberance. 3. Superciliary ridge. 4. External angular process of the frontal bone. 5. Nasal bones. 6. Malar bone. 7. Nasal septum. 8. Opening of the nose. 9. Incisive fossa. 10. Neck of lower jaw. 11. Angle of the jaw. 12. Anterior mental foramen. 13. Symphysis. 14. Base of lower jaw. 15. Canine fossa. 16. Infra-orbital foramen. 17. Malar bone. 18. Spheno-maxillary fissure. 19. Sphenoidal fissure. 20. Internal angular process of the frontal bone. 21. Trochlear depression. 22. Supra-orbital foramen. 23. Coronal suture.

bottom into two lateral openings by the anterior edge of the vomer; the *inferior nasal spine* projects from the middle of the lower border of this opening, and below it is the line of union between the maxil-

lary bones, separating the two *myrtiform* or *incisive fossæ.* Marking the surface transversely below are the two *alveolar borders* containing the *dental arches;* the latter consist each of sixteen teeth; the superior of the two arches is the larger and slightly overlaps the inferior. Upon the lower jaw is seen the median vertical line or ridge of the *symphysis*, terminating below on the triangular surface of the eminence of the chin. On each side of the median line is the *incisor fossa*, and also the *mental foramen*, below which commences the *external oblique ridge.*

2. The *superior region* is formed by the roof of the cranium, and is included between the external occipital protuberance and the frontal eminences, and laterally, between the two temporal ridges. It is almost regularly convex, and presents no irregularities or marks except the two parietal foramina, the parietal prominences, and the sutures, or lines of union between the bones. Of the last there are: 1. The *coronal*, formed between the frontal and parietal bones and crossing the region anteriorly in a curve, whose convexity presents backward. 2. The *sagittal*, occupying the median line between the superior borders of the parietal bones, and extending from the middle of the preceding to the middle of the 3d, the *lambdoidal*, which crosses the posterior part of the region between the superior borders of the occipital and the posterior of the parietal bones, and frequently presents along its course small loose pieces of bone called *Wormian* or *triquetrous bones.*

3. The two *lateral regions* are triangular, and may be marked off by lines drawn between the external angular process of the frontal bone, the angle of the jaw, and the mastoid process. For convenience of reference each of these is divided into three sub-regions, called, respectively, the temporal, zygomatic, and mastoid.

The *temporal region*, or *fossa*, the largest of the three subdivisions, is limited *above* by the temporal ridge which extends in an arched direction from the external orbital process to the root of the zygoma; *below*, by a slight ridge that crosses the greater wing of the sphenoid bone; *anteriorly*, by the posterior surface of the malar or cheek-bone, and *posteriorly*, by the root of the zygoma, the zygomatic arch crossing between the latter two points. Upon its surface, which, although depressed below the level of the surrounding parts, is convex, and for the most part occupied in the recent state by the temporal muscle, may be seen: (1) numerous arborescent grooves for the deep temporal artery and its branches; (2) the squamous suture, formed between the squamous portion of the temporal bone and the lower

edge of the parietal and external border of the great sphenoidal wing, the latter two overlapped by the former; (3), the angle of union between the parietal, frontal, and sphenoid bones, at which the parietal overlaps the frontal, but is overlapped by the sphenoid; (4), the spheno-maxillary fissure, communicating between the cavity of the orbit and the temporal fossa, and closed in front by the articulation between the malar and maxillary bones.

The *zygomatic fossa* is situated below and internal to the zygomatic arch, and is formed by the tuberosity of the superior maxilla in front, by the horizontal portion of the great wing of the sphenoid above, and internally, by the external plate of the pterygoid process and a small portion of the palate bone. Upon the posterior part of its superior wall is the *spinous foramen*, through which passes the middle meningeal artery; in front of this, the *oval opening* for the third branch of the fifth nerve. Between its anterior and internal walls is the *pterygo-maxillary fissure*, which is closed below by the union between the palate and superior maxillary bones, and unites above with the spheno maxillary fissure at a right angle; near the point of union may be found: 1, the *round foramen*, through which the second branch of the fifth nerve passes; 2, the anterior orifice of the *pterygoid or Vidian canal;* 3, the *posterior palatine foramen;* 4, the *spheno-palatine canal.*

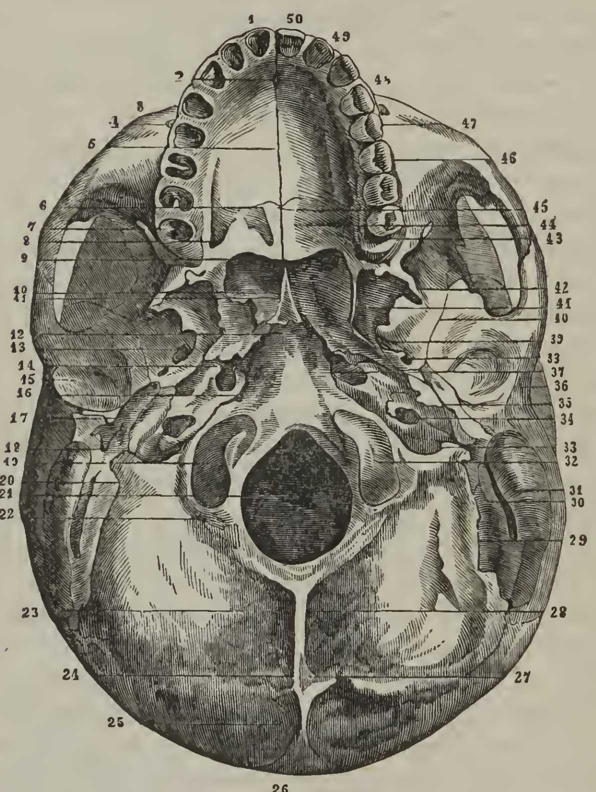
The *mastoid region* comprises that part of the external surface of the temporal bone situated behind the two roots of the zygoma. Upon it is found the *mastoid process*, together with the foramen and groove of the same name; the former above, and the latter internal to the root of the process. In the centre of the surface, is the *external auditory meatus*, and in front of this and between the two roots of the zygoma, the *glenoid fossa*, divided by the *glenoid fissure* into an anterior concavo-convex surface for articulation with the lower jaw, and a posterior concave for the lodgement of a part of the parotid gland.

4. The *inferior region* or *base* of the skull has an oval outline, and extends from the inferior border of the lower jaw to the external occipital protuberance and to the mastoid processes. It is divided into three parts, anterior, middle, and posterior.

The *anterior division* is formed by the inferior surfaces of the palate processes of the superior maxillary and palate bones, constituting what is known as the *hard palate*, and by the internal surface of the body and rami of the inferior maxilla. The former rough, for the attachment of the lining membrane of the mouth, is marked

in the median line by the suture between the opposite bones, at the anterior extremity of which is the *incisive foramen*, and inferior orifice of the *anterior palatine canals;* its posterior edge is sharp and slightly concave upon each side of the middle pointed process called

Fig. 86.



Base of the cranium. 1, 7. Alveolar margin of the upper jaw, marked by the alveolar cavities. 2. Incisive foramen. 3. Malar bone. 4. Infra-orbitar foramen. 5. Iuter-maxillary suture. 6. Suture between the palate processes of the upper maxillary and palate bones. 8. Posterior palatine foramen. 9. Posterior margin of the hard palate, formed by the junction of the palate bones. 10. Posterior nares. 11. The vomer, forming part of the nasal septum. 12. Basilar process of the occipital bone. 13. Oval foramen of the sphenoid bone. 14. Middle lacerate foramen. 15. Glenoid cavity of the temporal bone. 16. Occipito-petrous fissure. 17. Styloid process. 18. Stylo-mastoid foramen. 19. Occipital condyle. 20. Jugular eminence. 21. Occipito-spinal foramen. 22. Posterior condyloid foramen. 23. Depressions for the attachmeut of muscles. 24, 28. Vertical spine or crest of the occiput. 25. Space between the superior and inferior semicircular occipital ridges. 26. External occipital protuberance. 27. Inferior semicircular ridge. 29. Lambdoidal suture. 30. Groove for the digastric muscle. 31. Mastoid process. 32. Left occipital condyle. 33. Posterior lacerate foramen. 34. Inferior orifice of the carotid canal. 35. Petrous portion of the temporal bone. 36. Base of the zygomatic process of the temporal bone. 37. Anterior orifice of the carotid canal. 38. Spinal foramen of the sphenoid bone. 39. Oval foramen. 40. Spheno-temporal suture. 41. Pterygoid fossa. 42. External plate of the pterygoid process. 43. Wisdom tooth. 44. Palate process of the palate bone. 45. Inter-palatal suture. 46. First molar tooth. 47. Second bicuspid tooth. 48. First bicuspid. 49. Cuspid tooth and second incisor. 50. First incisor tooth.

the *palate* or *posterior nasal spine*, and gives attachment to the soft palate. In front of the extremities of this edge are the orifices of the *posterior palatine canals*. The internal surface of the lower jaw and the dental arches form the anterior and lateral boundaries of this anterior division of the base. The *middle division* may be marked off by two lines, one extending from the pterygoid to the mastoid process, and the other, between the two mastoid processes. In the median line anteriorly, the posterior edge of the vomer separates the posterior terminations of the nares, which are two large quadrilateral openings formed between the body and pterygoid process of the sphenoid and the palate processes of the palate bones, each measuring about twelve lines vertically and six transversely. External to these, and between the plates of each pterygoid process, is the *pterygoid fossa*, completed below by the palate bone, and at the root of the process the *scaphoid fossa*, in which the circumflex palate muscle has its origin. At the outer side of the root of the process are the oval and spinous openings, and still farther externally the glenoid fossa, already described in connection with the lateral region of the skull. Behind the vomer is the *basilar process* of the occipital bone, wedged in, as it were, between the internal extremities of the petrous portions of the temporal bones. Upon each of the latter may be remarked the *styloid process*, the *stylo-mastoid foramen*, the inferior orifice of the *carotid canal*, and on its posterior edge the jugular fossa, converted into a large foramen (posterior lacerate foramen), by the occipital bone, and occupied in the recent state by the jugular vein and eighth pair of nerves, the latter placed in front of the former, and separated from it by a projecting crest of bone which divides the foramen obliquely. At the side of the basilar process is an irregular-shaped opening (middle lacerate foramen), with rough jagged margins, formed in a great measure by a deficiency in the apex of the petrous bone, but closed in the recent state by a thin plate of cartilage; the anterior orifice of the carotid canal appears at the same point. Immediately in front of this opening, and forming a part of its margin, is the *spinous process* of the sphenoid bone, and at the base of this the *spinous foramen*. Along the line of union between the petrous portion of the temporal and the great wing of the sphenoid bone, is a groove which lodges the cartilaginous part of the Eustachian tube, and leads to the bony canal situated in the receding angle of the former bone.

The *posterior* part of the base of the skull presents in the median line the large *occipito-spinal foramen* (foramen magnum), which trans-

mits the spinal cord and its membranes, the spinal accessory nerves and vertebral arteries; extending from this foramen to the occipital protuberance, is the vertical ridge from which the two curved lines pass off on each side. These lines, or rather ridges, and also the spaces included between them, give attachment to muscles. Upon the margin of the foramen, a little in front of its transverse diameter, are the two *condyles* which articulate with the first cervical vertebra. Behind each of these condyles is a well-marked depression (posterior condyloid fossa), and the opening of the posterior condyloid canal, which lodges a small vein; in front, is another but much smaller, called the *anterior condyloid*, and also a foramen of the same name, which transmits the hypoglossal or lingual nerve.

THE INTERIOR OF THE SKULL.

The internal parts of the skull consist of the cranial, orbital, and nasal cavities.

The CAVITY OF THE CRANIUM is inclosed by an arched vault or ceiling resting upon an irregular floor or base.

The *vault* is formed by the vertical portion of the frontal bone, the two parietal, the squamous portions of the temporal, and upper half of the occipital. It is almost regularly concave, and over the whole of its surface may be seen the digital impressions and mammillary eminences, corresponding to the convolutions and sulci of the brain, and, upon each side, three sets of arborescent grooves for the lodgement of the anterior, middle, and posterior meningeal arteries. In the median line anteriorly, is the ridge for the attachment of the falciform process of the dura mater, and the groove which lodges the longitudinal sinus. This groove is small anteriorly, where it passes along the summit of the ridge, but increases in breadth from before backward, and, having reached the internal occipital protuberance, divides into the two lateral grooves. Along the median line may also be seen the sagittal suture, and upon each side of this, numerous oval depressions formed by the Pacchionian bodies, and posteriorly, the parietal foramen. Farther outward are the depressions corresponding to the parietal prominences, and anteriorly, similar ones corresponding to the frontal.

The *floor* or base of the cranium is very irregular, and marked off upon each side into three fossæ, known from their relative position as the anterior, middle, and posterior.

The *anterior fossæ*, one upon each side, are formed by the convex surfaces of the orbital plates of the frontal bones and the lesser wings of the sphenoid, and are marked by eminences and depressions, corresponding to the convolutions of the brain, whose anterior lobes they support. Between the two are the two grooves for the lodgement of the olfactory nerves, situated upon the cribriform plate of the ethmoid bone, and separated from each other by the ethmoidal crest (crista galli); in front of this last is the blind opening (foramen cœcum), in which the superior longitudinal sinus takes its commencement.

The *middle fossæ* are formed by the greater wings of the sphenoid, the anterior surface of the petrous, and the squamous portions of the temporal bones, and separated from the anterior by the posterior edge of the lesser wings of the sphenoid. They are deeply concave, and, besides the ordinary cerebral depressions and eminences, present grooves for the middle meningeal arteries. Anteriorly, each fossa communicates with the orbital cavity by the sphenoidal fissure, behind which may be seen the round and oval openings. Between the fossæ is the body of the sphenoid bone with its pituitary fossa; in front of this, the optic foramina, and anterior clinoid processes; behind the clivus and posterior clinoid processes, and upon each side, is the groove for the internal carotid artery. In the apex of the petrous bone is the internal orifice of the carotid canal, and a little removed externally, a small groove leading to the Vidian canal (hiatus Fallopii). The middle fossæ lodge the middle lobes of the cerebrum.

The *posterior fossæ*, larger and deeper than the others, are formed by the occipital and temporal bones, and contain the lateral lobes of the cerebellum. The anterior wall of each is formed by the posterior surface of the petrous bone, presenting the internal auditory foramen, and, a little above this, the opening of the aqueduct of the vestibule. Farther back may be observed the deep groove of the lateral sinus, which, commencing opposite the internal occipital protuberance, runs along the crucial ridge, then curves downward over the mastoid portion of the temporal bone, and terminates at the jugular foramen. Between the two are the basilar process of the occipital bone, and the occipito-spinal foramen, the former somewhat excavated for the Varolian bridge, and oblong medulla; external, and a little in advance of the occipito-spinal opening, are the two jugular foramina partially divided by the jugular eminence.

The Orbital Cavities.—The orbits are situated below the base of the cranium, above the maxillary sinuses, and external to the cavities of the nose. They are formed by parts of seven different bones, namely, the frontal, sphenoid, superior maxillary, palate, unguiform, or lachrymal, ethmoid, and malar; are quadrangular pyramidal in shape, and present for consideration a superior, an inferior, an internal, and an external surface or wall, four angles, a base, and an apex.

The *superior wall* or roof of the orbit is formed by the orbital plate of the frontal bone and the smaller wing of the sphenoid; it is concave and marked posteriorly by a transverse suture, and anteriorly by two superficial depressions for the lodgement of the lachrymal gland, and the cartilaginous pulley of the superior oblique muscle of the eye. The former of these depressions, called the *lachrymal fossa*, is large but shallow, and is situated just within the external angular process of the frontal bone; the latter is small, not always distinct, and placed near the internal angular process. At the extreme back part is the optic foramen, which transmits the optic nerve and ophthalmic artery.

The *inferior wall* or floor of the orbit is formed by the orbital plates of the palate, malar, and superior maxillary bones, of which the last mentioned is the principal. It is nearly plain, inclines a little outward as well as downward and forward, and presents at its posterior angle the palato-maxillary suture; in front of this a groove leading forward to the infra-orbital canal, and external to the latter the suture between the malar and maxillary bones.

The *external wall*, also nearly plain, is formed by the sphenoid and malar bones, and is marked only by the suture between the two, and by one or more small foramina for the passage externally of nervous filaments and vessels. The great outward inclination of this surface, however, deserves to be noticed as giving to the axis of the orbits their divergent direction.

The *internal wall* is less extensive than any of the others, and nearly parallel with its fellow of the opposite side. It is formed by the ethmoid and lachrymal bones and the ascending process of the superior maxillary, and is marked by the sutures between these bones and in front by a vertical groove, leading downward to the nasal duct. The groove lodges the lachrymal sac, which communicates through the nasal duct with the inferior meatus of the nose.

The *angles* formed by the four walls are named, from their position, superior, external, inferior, internal, &c. The *superior internal* is marked by an antero-posterior suture formed between the orbital

plate of the frontal bone above, with the lachrymal and ethmoid below, and by two small foramina, called, respectively, the anterior and posterior internal orbital, the former for the passage of the nasal branch of the ophthalmic nerve, the latter for the ethmoidal artery. The *inferior internal angle* presents only the suture formed by the junction of the lachrymal and ethmoid with the superior maxillary and palate bones. The *superior external angle* is closed only in the anterior half of its extent, where sutures formed by the frontal, sphenoid, and malar bones may be seen; posteriorly is the sphenoidal fissure, a large triangular opening, situated between the greater and smaller wings of the sphenoid, and transmitting numerous vessels and nerves before enumerated.

The *inferior external angle* is also open in the greater part of its extent. The cavity of the orbit here communicates with the zygomatic fossa by a long narrow slit, called, from its situation, the spheno-maxillary fissure, but is closed in front by the union between the malar and maxillary bones.

The *base* of the orbit is open and quadrangular, and a little broader transversely than vertically; it is directed forward and outward, being cut, as it were, obliquely outward and backward. Its area is less than that of the cavity immediately within, all four of its margins being bent, as it were, inward. Upon the superior margin, will be observed the supra-orbital foramen or notch for the passage of the supra-orbital or frontal branch of the ophthalmic nerve. The *apex* corresponds to the optic foramen, and the internal extremity of the sphenoidal fissure. The *axis* of the two orbits, as already intimated, are not parallel, and if continued backward, would cross each other upon the body of the sphenoid bone.

THE NASAL CAVITIES.—The nasal fossæ are two large fissure-like cavities which are situated above the roof of the mouth and between the orbits, and extend from the surface of the face to the pharynx. They are separated from each other by a median septum which forms their internal wall; besides which, each is considered as having an external, a superior, and an inferior wall, and two openings.* The frontal sinuses, ethmoidal cells, maxillary sinuses, and sphenoidal cells, are also continuations of the same.

* For the purpose of studying these fossæ it is necessary to have a skull sawn from before backward, a little to one side of the median line, so as to leave the septum entire upon one side.

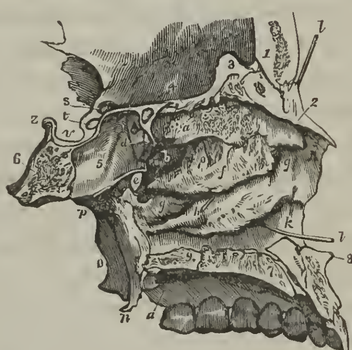
11

The *superior wall* or roof is arched, and extends from the anterior to the posterior opening; it is formed by the nasal bone in front, the cribriform plate of the ethmoid in the middle, and the body of the sphenoid behind.

The *inferior wall* or floor is formed by the palate processes of the superior maxillary and palate bones, and is nearly horizontal; it is much broader than the superior, slightly concave from side to side, and rough for the attachment of the lining membrane; near its anterior extremity may be seen the superior opening of the anterior palatine canal.

The *internal wall* or nasal septum is formed by the nasal plate of

Fig. 87.



A longitudinal section of the nasal fossa made immediately to the right of the middle line, and the bony septum removed in order to show the external wall of the left fossa. 1. The frontal bone. 2. The nasal bone. 3. The ethmoidal crest. 4. The cribriform plate of the ethmoid. 5. Part of the sphenoidal cells. 6. The basilar portion of the sphenoid bone. Bones 2, 4, and 5, form the superior boundary of the nasal fossa. 7, 7. The articulating surface of the palatine process of the superior maxillary bone. The groove between 7, 7, is the lateral half of the incisive canal, and the dark aperture in the groove the inferior termination of the left naso-palatine canal. 8. The nasal spine. 9. The palatine process of the palate bone. *a*. The superior turbinate bone, marked by grooves and apertures for filaments of the olfactory nerve. *b*. The superior meatus. *c*. A probe passed into the posterior ethmoidal cells. *d*. The opening of the sphenoidal cells into the superior meatus. *e*. The spheno-palatine foramen. *f*. The middle turbinate bone. *g*, *g*. The middle meatus. *h*. A probe passed into the infundibular canal, leading from the frontal sinuses and anterior ethmoid cells; the triangular aperture immediately above the letter is the opening of the maxillary sinus. *i*. The inferior turbinate bone. *k*, *k*. The inferior meatus. *l*, *l*. A probe passed up the nasal duct, showing the direction of that canal. The anterior letters *g*, *k*, are placed on the superior maxillary bone, the posterior on the palate bone. *m*. The internal pterygoid plate. *n*. Its hamular process. *o*. The external pterygoid plate. *p*. The situation of the opening of the Eustachian tube. *q*. The posterior palatine foramina. *r*. The roof of the left orbit. *s*. The optic foramen. *t*. The groove for the last turn of the internal carotid artery converted into a foramen by the development of a little osseous spiculum uniting the anterior clinoid process to the side of, *v*, the pituitary fossa. *z*. The clivus or posterior clinoid process.

the ethmoid and the vomer; it is thin, nearly vertical in its direction, inclining, however, very frequently, a little to one side, generally the

left, and extends from the roof to the floor. It is, however, deficient anteriorly and inferiorly, but completed in the recent state by a triangular plate of fibro-cartilage.

The *external wall* is formed by parts of the ethmoid, superior maxillary, lachrymal, inferior turbinate, and palate bones, and presents for consideration, commencing above: 1, a smooth plane surface terminating behind in a small curved lamella, called the *superior turbinate* or *spongy bone;* 2, a narrow groove, the *superior meatus*, situated behind the plane surface and below the superior turbinate bone, communicating with the posterior ethmoidal cells, and at its posterior termination with the spheno-palatine foramen; 3, the *middle turbinate bone* is also a portion of the ethmoid, but longer and more curved; 4, the *middle meatus*, a well-marked groove placed beneath the middle turbinate bone, and communicating in front with the anterior ethmoid cells, and near the middle with the maxillary antrum; 5, the *inferior turbinate bone;* 6, the *inferior meatus*, or groove, the largest of the three, situated between the preceding bone and the floor of the nose, and communicating with the nasal duct, whose orifice is placed close beneath the margin of the turbinate bone anteriorly.

In the recent state, the nasal cavities are lined by the Schneiderian or pituitary membrane, which, however, does not materially alter the general configuration of the parts, except to narrow the foramina that open into the meatuses.

The Frontal, Sphenoidal, and Maxillary Sinuses, and Ethmoidal Cells.—The *frontal sinuses* are cavities contained in the lower part of the vertical or frontal portion of the frontal bone. They are formed by a bulging forward of the external table of the bone, and vary in size and number at different ages and in different individuals. As a general rule, they consist in the adult of two or three irregular cells or compartments on each side of the median line, capable of containing altogether about a drachm of fluid. The cells of each side open into each other and into the anterior ethmoidal cells below, but not into those of the opposite side, a median bony septum separating them. In the recent state, they are lined by a prolongation of the nasal mucous membrane, whose surface they thus serve to extend. They also increase the strength of that part of the cranial wall in which they are situated without adding to its weight. The latter purpose, however, is by no means so evident in man as in some

of the inferior animals, the ox, horse, &c., for example, in whom they constitute the great bulk of the skull.

These cells are almost entirely wanting in infancy, but are gradually developed after eight or ten years, and attain in old age a very large size.*

The *sphenoidal cells* or *sinuses* occupy the body of the sphenoid bone and communicate in front with the posterior nares. Like the preceding they are wanting in young subjects, but are gradually developed as age advances, so that, after middle life, they occupy the whole of the body of the bone, and sometimes extend even into the lesser wings and into the orbital process of the palate bone. The number of these cells varies; sometimes there are two or three on one side and only one large one on the other, and, at other times, there are a number on both sides. They are almost always separated by a bony septum, which, however, is not often exactly in the median line.

In early life, the anterior wall of the body of the sphenoid bone is covered in, on each side of the rostrum, by the pyramidal processes of the ethmoid, and, as the cells in each become developed, those of the former bone communicate with the cells of the processes, and through them with the nose; but after the age of twenty-five or thirty, the two become blended with each other, and what was once the pyramidal process is then a part of the anterior wall of the body of the sphenoid.

Like the frontal, the sphenoidal sinuses are lined by an extension of the Schneiderian membrane, and open upon each side of the rostrum upon a level with the superior meatus of the nose.

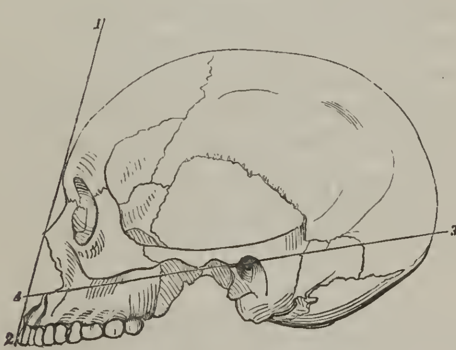
The *maxillary sinus*, or *antrum*, has been already noticed in connection with the superior maxilla, in the body of which it is situated. It is earlier in its development than either of the preceding, being present at birth, and does not seem to increase much in size after maturity. It is lined by a continuation of the mucous membrane of the nasal fossæ, with which it communicates beneath the curved border of the middle turbinate bone, by an orifice about the size of a crow-quill; in the skeleton state this opening is much larger.

* In the Museum of the University of Louisville is a skull, taken from an idiot boy about sixteen or eighteen years of age, in which the frontal sinuses are very large, and extend outward over the orbital arch as far as the commencement of the temporal ridge. They are formed entirely by the separation of the *internal* table of the bone from the external, there being no superciliary prominences whatever.

The *ethmoidal cells* are situated in the lateral masses of the ethmoid bone, in which connection they have already been mentioned. They do not all communicate with each other, but are divided into an anterior and a posterior set; the former; large and numerous, open into the frontal sinus and middle nasal meatus in front by a large funnel-shaped passage (infundibulum); the posterior are small and communicate with the superior meatus. They are lined by a continuation of the nasal mucous membrane.

Relative Size of the Cranium and Face.—The brain being the organ of intelligence and the face the seat of the senses, the relative development of the cranium marks the position of the different vertebrate animals in the scale of animal creation, and reaches its highest point in the human family. But very great differences exist among individuals of the same class, and these are to some extent indicated by differences in what is called the *facial angle.* This angle, first proposed by Camper, is measured by two lines, one drawn from the anterior margin of the upper jaw to the most prominent part of the forehead, and the other from the middle of the external opening of the ear to the lower edge of the nasal opening in front, and a little beyond to the preceding. The two annexed plates, taken from *Morton's Anatomy*, exhibit the exact position

Fig. 88.



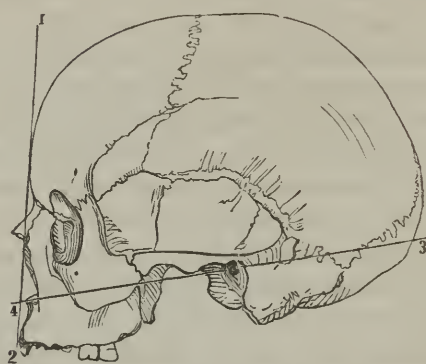
The facial angle measured on a Shoshonee Indian.

of these lines, and also the difference between the angle in the Caucasian and American races.

According to Dr. Morton's measurements the facial angle of the Caucasian is about 80°, sometimes rising as high as 83° or 85°, and

rarely falling as low as 75°. In the negro, the average is 75°, not often falling to 70°. The Mongolian is about 77°, but the Indian

Fig. 89.



The facial angle measured on an ancient Egyptian head.

and Malay are no larger than the negro. According to the same observer, the average for the aborigines of America is 75.5°.

But, as Dr. Morton very justly observes, the facial angle is by no means a proper criterion of mental intelligence, but chiefly shows the projection of the face in relation to the skull without conveying the least idea of capacity of the cranium, which is often the same in heads of very different facial angles and diameters. "But although a full angle is no proof of superior intelligence, the converse of this is for the most part true; for a very contracted angle, whether in nations or individuals, is generally accompanied by a low grade of mental development. Thus, in most savage tribes, the face is protruded at the expense of the head; while, in the idiot, this disparity is often yet more remarkable, and even exceeds that of some of the monkey tribes."

Form of the Skull.—The form of the skull and capacity of the cranial cavity present some remarkable dissimilarities in the five races of the human family, the principal of which are thus summed up by Dr. Morton.*

1. The *Caucasian race* has a large oval skull and a face small in proportion. The nasal bones are arched and narrow, the zygomæ small and receding, the chin full, and the teeth vertical, with a facial

* System of Human Anatomy.

angle of 80°. There is a harmony of proportion in the cranial structure of this race which is comparatively rare in any of the others.

2. The *Mongolian race.*—In the Mongolian nations the skull is oblong-oval, rather flattened at the sides, with a low forehead, and a very broad and full occipital region. The nasal bones are broad and depressed, the face prominent, the jaws large, the cheek-bones broad and flat, and the zygomatic arches expanded; the facial angle is 77°.

3. The *Malay race* strongly resembles the Mongolian. The head is high and squared or rounded, the forehead low, the face very broad and projecting, the teeth salient, the nose flat; facial angle 75°.

4. The *American race.*—The skull of the American Indian is small and rounded, with a receding forehead, vertical occiput, great width between the parietal bones, large salient nose, heavy jaws and teeth, and prominent face; facial angle is 75°.

5. The *Negro race* is remarkable for a long narrow skull, a low forehead and coronal region, full occiput, short, flat nasal bones, ponderous maxillæ, large teeth, and projecting face; facial angle 75°.

Capacity of the Cranium.—The average capacity of the cranial cavity of the Caucasian race, deduced from an examination of a great number of skulls by Dr. Morton, is about ninety cubic inches, with a maximum of one hundred and thirteen cubic inches, the latter the head of a German. The head of the late Mr. Webster, however, exceeded this by nine cubic inches, measuring one hundred and twenty-two cubic inches. But even this last is surpassed by a skull in the museum of the University of Louisville, which the author, with the assistance of Prof. B. Silliman, Jr., found to measure 125.77 cubic inches.* This last is the skull of a German baker, who, according to Prof. Cobb, of the Medical College of Ohio, by whom the specimen was obtained, except that he made a tolerably

* The external measurements of this remarkable skull are as follows:—

Occipito-frontal diameter, measured from the forehead about an inch above the nasal boss to the most prominent point of the occiput the same distance above the external occipital protuberance,	$8\frac{1}{4}$ inches.
Bi-parietal diameter,	$6\frac{1}{4}$ "
Vertical diameter, measured from the anterior part of the sagittal suture to the anterior edge of the occipito-spinal foramen,	$6\frac{1}{5}$ "
Circumference,	$23\frac{3}{4}$ "
Over the vertex between the centres of the auditory meatuses,	$14\frac{3}{4}$ "

good loaf of bread, gave no evidence whatever of more than ordinary intelligence.

Diameters of the Cranium.—Dr. Morton gives the average external diameters of the European and anglo-American skulls as follows:—

Longitudinal or *occipito-frontal diameter*, measured between the most prominent part of the frontal bone (generally between the superciliary ridges) and the occipital protuberance, - - - - $6\frac{1}{2}$ inches.

Lateral or Bi-parietal diameter, measured between the parietal protuberances, - - - - $5\frac{1}{2}$ "

Vertical diameter, measured between the occipital condyles below and the top of the vertex, - - 5 "

THE THORAX.

The thorax is a bony cage, formed by the soft parts into a close cavity to contain the central organs of circulation and respiration. In the skeleton, it is composed of the dorsal vertebræ, the sternum and the ribs, with their terminal cartilages. The vertebræ have been already described.

THE STERNUM.

The sternum, or breast-bone (Fig. 90), constitutes the middle anterior part of the thoracic wall, forming a shield for the protection of the organs within, and a basis of support for the ribs and clavicles, and through the latter for the superior extremities. It belongs to the class of flat bones, and measures from six to eight inches in length, and from one and a half to two and a half in breadth; it is directed obliquely from above downward and forward. It was compared by the older anatomists to a gladiator's sword with its handle presenting above. Considering as one the several pieces of which the bone is composed in the young subject, it is somewhat triangular, and presents two surfaces, three borders, and an extremity or point.

The *anterior surface* is slightly convex, and traversed by three or four transverse lines or ridges indicating the points of union between the original pieces. The uppermost of these lines is always well-

marked, and the surface above differs from that below in being slightly convex transversely, and concave in a vertical direction. In fact, the bone often forms a decided angle at this line; the upper part being bent back as it were, presents the appearance of a fracture. The *posterior surface* does not differ materially from the anterior except in being slightly concave, especially, in many instances, in a vertical direction.

The two *lateral borders* are thick, and each presents seven articular pits with raised margins for the reception of the extremities of the costal cartilages. The uppermost of these cavities is placed near the corresponding extremity of the border, is shallower than the rest, and triangular; it is separated from the second, which is situated at the extremity of the superior transverse line, by a nearly straight edge at least an inch in length. Below the second, the interspaces are lunated and become rapidly smaller, until at the lower part of the border, they form only a narrow septum between the pits. The *superior border* is about two inches and a half in length, and is much the thickest part of the bone. It is well rounded, slightly lunated, and presents at each extremity a large depression, convex antero-posteriorly, for articulation with the clavicle. The *point* or *extremity* of the bone generally remains cartilaginous to an advanced age, and is commonly called the *ensiform** or *xiphoid*† *cartilage*. In size, shape, and direction, it varies remarkably in different individuals; sometimes it is bifurcated, sometimes perforated, often short and blunt, and at other times long, thin, and narrow, bent to one side, or curved in an anterior or posterior direction.

The sternum is composed of an open, spongy, or diploic substance, inclosed between two thin tables of compact tissue. It is developed from five points, forming as many separate pieces, which unite successively from below upward. Sometimes one or more of these pieces is developed from two lateral points, which accounts for the vertical division, and also for the presence of large foramina often found occupying the middle lower part of the bone. The first ossific point is discovered about the sixth month of fœtal life, but the bone is not entirely completed, by the union of the several pieces, until the thirtieth or fortieth year. Union at the superior transverse line is the last to take place, and often entirely fails. The ensiform cartilage begins to ossify between the second and fifteenth year,

* *Ensis*, a sword. † Ξιφος, a sword.

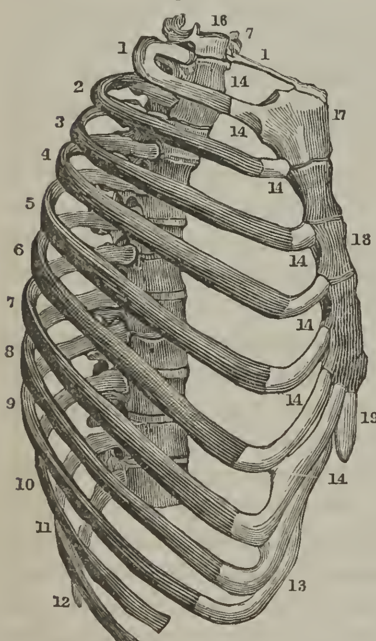
varying in different individuals, and often remaining through life only partially completed.

The sternum articulates with the clavicles and with fourteen costal cartilages, seven on each side.

THE RIBS.

The ribs or costæ, the long flat bars of the thoracic cage, are curved and somewhat twisted, and extend on each side from the dorsal vertebræ obliquely downward and forward toward the sternum, to whose lateral borders they are prolonged by the costal cartilages. They are twelve in number on each side, rarely varying in this respect; and in designating them numerically, the uppermost is always taken as the starting-point. The first seven are often termed the *true*, and the last five the *false* ribs, because the former are provided with separate articular pits on the sternum. The last two, having their anterior extremities unattached, are sometimes called the *floating* ribs.

Fig. 90.



Lateral view of the ribs and sternum. 1 to 12. The twelve ribs. 13. Cartilages of the false ribs. 14, 14. Cartilages of the true ribs. 16. First dorsal vertebra. 17. First bone of the sternum. 18. Second sternal bone. 19. Third part of the sternum, or ensiform cartilage.

The ribs are arranged one above another and incline obliquely from the spinal column, the degree of obliquity increasing successively from the first to the twelfth. In consequence of this, the included intercostal spaces are broader in front than behind, especially the first. The *length* of the ribs increases from the first to the eighth, below which it rapidly diminishes. Their *breadth*, which is always greatest anteriorly, gradually decreases from the first to the last. Their *curvature* is not regular, the posterior part of each representing the segment of a much smaller circle than

the anterior, but in general it diminishes from the first to the twelfth. Besides this curvature, each rib has a slight twist, whose commencement posteriorly, constitutes what is called the *angle* of the rib.

Each rib presents an internal and an external surface, two borders, and two extremities.

The *external surface* is irregularly convex, and, within one and a half or two inches of the posterior extremity, presents an oblique transverse line corresponding to the angle, and, near the anterior extremity, a faintly-marked ridge indicating the attachment of the great serrate muscle. The *internal surface* is smooth and concave, and presents, near the inferior edge anteriorly, the continuation of the groove found upon the lower border. The *superior border* is curved, thick, and rounded; upon it may be seen traces of an internal and an external lip or ridge. The *inferior border* has a greater curvature than the superior; is thin and sharp anteriorly, but grooved in the posterior two-thirds of its extent for the intercostal vessels and nerves. The two margins or lips of the groove give attachment to the superficial and deep intercostal muscles.

The *posterior extremity* of the rib is expanded into a small oval *head*, and presents a transverse ridge separating two smooth facets, of which the inferior is the larger, for articulation with the half pits upon the sides of the dorsal vertebræ. Just beyond the head, the rib is constricted into a *neck*, external to which is an eminence, called the *tubercle*, for articulation with the extremity of the transverse process of the lower of the two vertebræ between which the head is placed.

The *anterior extremity* is broad but not very thick, and grooved for the reception of the extremity of the costal cartilage.

The *first rib* is the shortest and broadest, and is curved only in the direction of its edges, its two surfaces being flat. As it is the shortest its curvature is the greatest. Its head is small, and presents but a single articulating facet; its neck is long and cylindrical; its tubercle prominent and placed upon the edge of the bone; its anterior extremity very broad, and often joined to the sternum without any intervening cartilage. Its superior surface looks directly upward, and is crossed about the middle by an oblique ridge or eminence, which gives attachment to the anterior scalene muscle, and separates two superficial grooves for the subclavian artery and vein.

The *second rib* is nearly twice as long as the first, but not so broad; it is destitute of any twist, and presents, upon its superior surface,

which inclines a little outward and forward, a rough eminence for the attachment of the posterior scalene muscle.

The *eleventh* and *twelfth ribs*, the only ones remaining that require separate mention, are the least curved and the narrowest of all. Their heads present but one articular surface; they have no groove, and their anterior extremities are free, sharp, and pointed. They differ from each other only in their length, the twelfth being much the shorter.

The ribs belong to the class of broad bones, and, therefore, have no medullary canal. The body of the bone is developed from a single point of ossification, which makes its appearance early in fœtal life, so that at birth nearly the whole length of the bone is complete. The articular facets of the head and tubercle are developed each from a single ossific point, which does not appear before the fifteenth or sixteenth year.

THE COSTAL CARTILAGES.

The costal cartilages eke out the ribs anteriorly, and add very greatly to their elasticity and mobility. Those of the true ribs reach the lateral borders of the sternum, those of the eighth, ninth, and tenth extend only to the lower border of the cartilage above, while those of the eleventh and twelfth form only small tips to these bones. They increase in length successively from the first to the seventh, beyond which they gradually diminish. In size and shape they correspond very nearly to the ribs, but their direction is somewhat different; the first and second incline a very little downward, while all the others, with exception of the last one or two, ascend obliquely, the degree of ascent increasing successively from above.

It is not unusual to find the cartilages ossified in old subjects, and this is more particularly the case in regard to the first.

GENERAL CHARACTERS OF THE THORAX.

The thorax is situated at the upper part of the trunk, and, as before mentioned, incloses the principal organs of respiration and circulation. In situation, size, and structure, it holds a middle place between the other great cavities, the cranium and abdomen. Its size is subject to great variety in different individuals, but is gene-

rally greater in the male than in the female. In shape, it resembles a cone flattened from before backward, with its base below and summit above, but in females accustomed to tight lacing it is more of a cylindroid figure. It presents, externally, an anterior, posterior, and two lateral surfaces.

The *anterior surface* inclines obliquely from above downward and forward, and is more prominent in the female than in the male. The *posterior surface* is almost vertical in its direction, and presents upon each side of the spinal column a broad gutter, limited externally by the angles of the ribs, broader below than above, and occupied by the spinal muscles. The *lateral surfaces* are prominent and convex, and almost regularly oblique in their inclination from above downward and outward.

The *interior* of the thorax is also divisible into four surfaces, whose concavities correspond to the convexities of the external, except along the posterior wall, where the bodies of the vertebræ form an incomplete septum which divides the cavity, and forms upon each side a deep groove for the lodgement of the posterior rounded borders of the lungs.

The *base* of the thorax is cut, as it were, obliquely from before backward and downward, and presents a large, transversely elongated opening, whose circumference is formed by the last dorsal vertebra, the lower extremity of the sternum, the cartilages of the false ribs, and the bodies of the twelfth. In the recent state, the diaphragm closes this opening and forms the septum between the thoracic and abdominal cavities. In consequence of the obliquity of the base, the anterior wall of the thorax is much shorter than the posterior or the two lateral.

The *summit* of the thorax is truncated, and inclined from behind forward and a little downward. It presents a transversely oval opening, formed by the first rib upon each side, the superior margin of the sternum in front, and the body of the first dorsal vertebra behind. Through this opening pass the trachea, œsophagus, and numerous large bloodvessels and nerves. In the recent state, the plane of this opening does not limit the cavity of the thorax above, for the lungs extend hardly less than two inches higher than the margin of the first rib.

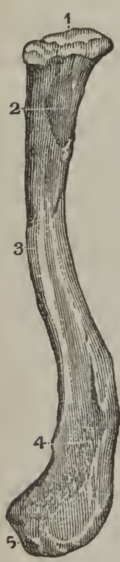
THE SUPERIOR EXTREMITIES.

The two superior extremities are attached to the upper lateral parts of the thorax, and consist of the shoulder, arm, forearm, and hand. The shoulder is formed by two bones, the clavicle and scapula.

THE CLAVICLE.

The clavicle,* the shortest long bone in the body, forms the anterior part of the shoulder, and is situated at the upper front part of the thorax, extending nearly horizontally from the sternum to the scapula. Its size, which varies greatly in different individuals, is always relative to the muscular development of the corresponding limb. Its shape is very irregular, being triangular prismatic in the internal two-thirds of its extent, flattened from above downward toward its external extremity, and curved horizontally like the italic letter *f*. Its *superior surface* is almost subcutaneous, broader externally than internally, and marked in the latter situation by a slight elevation for the attachment of the sterno-cleido-mastoid muscle. The *inferior surface*, also broader externally, presents near the internal extremity a rough tubercle for the attachment of the costo-clavicular ligament, and near the external, a similar one for the coraco-clavicular ligament. About the middle of this surface may also be seen the nutritious foramen and a longitudinal groove for the insertion of the subclavian muscle. The *anterior border* is thick and convex internally, where it gives origin to the great pectoral muscle, and narrow and concave externally for the attachment of the deltoid. The *posterior border* is large, rounded, smooth, and concave internally, but externally narrow, convex, and rough, for the insertion of the trapezius muscle.

Fig. 91.



Under surface of the clavicle of the left side. 1. Sternal end. 2. Tubercle for the attachment of the sterno-clavicular ligament. 3. Rough surface for the origin of the pectoral muscle. 4. Groove for the subclavian muscle. 5. Articular facet for the acromion.

* *Clavis*, a key.

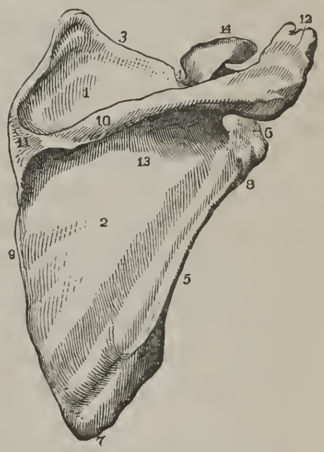
The *internal* or *sternal* extremity is prismatic, thick, and strong, and presents a triangular smooth surface, concave antero-posteriorly, and convex transversely, for articulation with the sternum. The posterior inferior of the three corners of this extremity is very prominent. The *external* or *scapular* extremity is vertically flattened, and presents a narrow, oblong, and convex surface for articulation with the acromion process.

The structure of the clavicle is like that of long bones in general, but its medullary canal is very small. It is developed from a single osseous point, that makes its appearance between the thirtieth and fortieth day of fœtal life, and at birth the bone is almost completely formed.

THE SCAPULA.

The scapula or shoulder blade is situated upon the upper part of the lateral and posterior surfaces of the thorax, extending from the first to the seventh rib. It belongs to the class of flat bones, is thin and triangular, and presents two surfaces, three borders, and three angles.

Fig. 92.



Posterior view of the scapula. 1. Supra-spinous fossa. 2. Infra-spinous fossa. 3. Superior border and angle. 4. Coracoid or supra-scapular notch. 5. Anterior or axillary margin. 6. Glenoid cavity. 7. Inferior angle. 8. Origin of long head of triceps. 9. Internal or vertebral border. 10. Spine. 11. Triangular facet made by the trapezius. 12. Acromion. 13. Base of the spine. 14. Coracoid process.

The *posterior* or *dorsal surface* is divided into two unequal parts by a vertically flattened triangular crest, called the *spine of the scapula*. It commences about an inch above the middle of the posterior border of the bone, in a smooth flattened surface over which the tendon of the trapezius muscle glides, crosses obliquely toward the anterior superior angle, over which it curves to form a broad shield-like process named the *acromion*. The spine does not, however, quite reach the angle, but forms a smooth concave border, which spreads out into the under surface of the acromion. The posterior edge, or crest of the spine, is quite thick, forming two well-marked lips, which are continuous with the margins of the acromion, and give attach-

ment to the trapezius and deltoid muscles. The *acromion* is flat and irregularly quadrilateral, and stands forward and outward behind and above the shoulder-joint; its superficial surface looks upward, outward, and backward, and is rough, convex, and subcutaneous; its deep surface is smooth and concave, and looks downward and forward; its circumference is continuous with the two lips of the spine, and, at its superior internal part, presents a transversely oval facet for articulation with the clavicle.

The dorsal surface above the spine is convex, but forms with the superior surface of the latter an angular fossa (*supra-spinous fossa*), occupied in the recent state by the supra-spinous muscle. Below the spine, the surface is also for the most part convex, and occupied by the infra-spinous muscle; but, near the internal border, it presents a broad well-marked longitudinal excavation, bounded upon its outer side by a narrow ridge, which gives origin at its middle to the small teres muscle, and spreads out below into an elongated flat surface for the attachment of the larger teres muscle.

The *concave internal surface* is called the subscapular fossa. It is marked by several oblique ridges, and almost entirely occupied by the subscapular muscle.

The *internal* or *vertebral border*, the longest of the three, is thin and somewhat curved, and gives attachment to muscles that draw the shoulder backward; it does not lie parallel with the spinal column, but inclines downward and outward.

The *superior border* is short and thin, and intersected by a deep notch (the *supra-scapular notch*), which is converted into a foramen by a ligament, and gives passage to the supra-scapular nerve. The *coracoid process* is external to this notch. It stands up from the external third of the border by a thick broad base, and, curving forward and outward, terminates in a rounded blunt extremity, whose surface is smooth and concave beneath, where it overhangs the shoulder-joint, and rough superiorly for the attachment of strong ligaments.

The *external* or *axillary border* is thick, and slightly grooved upon its inner aspect for the origin of a part of the great teres muscle. Near its superior termination is a roughness for the attachment of the long head of the triceps muscle.

The *inferior angle* is acute but rounded, and is covered externally by the origin of the greater teres muscle and by the margin of the latissimus which overlaps it, and is often attached to it by a small fleshy slip. The *internal* or *superior* is nearly a right angle, and

presents upon its inner aspect a rough impression for the insertion of the elevator muscle of the scapula.

The *external* or *anterior angle* forms the head of the scapula, which is supported by a broad *neck*. It is thick, elongated from above downward, and excavated for articulation with the head of the humerus. The excavated surface, termed the *glenoid cavity*, or *fossa*, is very shallow, smooth, and of an oval shape, the large end of the oval presenting inferiorly. In the recent state, this cavity is deepened by the articular cartilage, which is thinnest at the centre, and by the tendon of the long head of the biceps muscle, which forms a fibrous ring upon the circumference.

The scapula articulates with the clavicle and humerus. It is developed from six points of ossification, two for the acromion, and one for the body, the coracoid process, the internal border, and the inferior angle. Although one of the earliest bones in which ossification commences, it is not entirely completed until about the fifteenth year, when the coracoid process becomes joined to the body of the bone.

THE HUMERUS.

The humerus is situated between the scapula and the bones of the forearm. It belongs to the class of long bones, and is divided into a shaft and two extremities.

The *body* or *shaft* is irregularly cylindrical, somewhat flattened below, and slightly twisted upon itself at its middle. Upon its *anterior* aspect above is a well-marked groove, directed downward and a little outward, and reaching as far as the middle third of the bone; this is the *bicipital groove*, so called from its lodging the long tendon of the biceps muscle. Its sides are prominent and rough, and give attachment to muscles, the anterior to the great pectoral, and the posterior to the common tendon of the latissimus and greater teres. Internal to the lower part of the groove is the nutritious foramen leading obliquely downward into the interior of the bone; and, upon its external side, near the middle of the bone, a rough V-shaped eminence for the insertion of the deltoid muscle. Below the middle of the bone the anterior surface is broad, and divided by a blunt vertical ridge into two lateral planes, the internal looking forward and inward, and the external forward and outward. The *posterior* surface is narrow and rounded above, but broad below, and, owing to the torsion of the bone, looks a little inward above, and outward below. The division between these two portions is

marked by an oblique groove that lodges the musculo-spinal nerve and accompanying artery.

The two *borders*, separating the anterior and posterior surfaces, are prominent only in the lower half of the bone; they are continuous with the condyles of the inferior extremity, are rough and give attachment to muscles, and to a strong aponeurosis, that separates the muscles of the fore and back parts of the arm.

Fig. 93.

The right humerus, seen in front. 1. Head of the bone. 2. Greater tuberosity, and 3, its anterior facet, for the supra-spinous muscle. 4. Bicipital groove. 5. Insertion of the great pectoral muscle. 6. Lesser tuberosity of the humerus, for the attachment of subscapular muscle. 7. Neck of the bone. 8. Ridge for attachment of the latissimus muscle. 9. Triangular ridge for the attachment of the deltoid. 10. Origin of the anterior brachial muscle. 11. Origin of extensor muscles of the hand. 12. External condyle. 13. Articular head for the radius. 14, 15. Trochlea for the play of the ulna. 16. Internal condyle. 17. Coronoid cavity.

The *superior extremity* is the largest part of the bone, and presents (1) a smooth, convex, articular eminence called the *head* of the humerus, (2) a circular groove circumscribing the head, improperly called the *anatomical neck*, (3) a *greater* and *smaller tuberosity*, and (4) a constriction supporting the whole, named the *surgical neck*.

The *head* of the bone is placed obliquely to the axis of the shaft; it is smooth, and regularly convex, forming about one-third of a sphere, and, in the recent state, covered with cartilage for articulation with the scapula. The anatomical neck is merely a superficial furrow circumscribing the articular surface. The *tuberosities* are two rough eminences terminating the margins of the bicipital groove above, and placed upon a line with the shaft of the bone; the *greater* of the two is external and posterior, and marked by three small facets for the attachment of the supra and infra-spinous and small teres muscles; the *smaller*, more rounded and prominent, and situated anterior to the groove, gives insertion to the subscapular muscle. The *surgical neck* is the constricted part of the bone by which the head joins the shaft.

The *inferior extremity* of the humerus is flattened from before backward, and curved a little forward. It presents two condyles, an articular surface, and two excavations called, respectively, the olecranoid and coronoid cavities.

The *condyles* are two rough prominences for the attachment of muscles and the lateral ligaments of the elbow-joint; they are situated upon the inner and outer aspect of the bone at the inferior termination of its lateral borders. The *internal* is larger than the *external*, and inclines a little backward. Both are readily felt through the skin, and form important aids in the diagnosis of affections of the joint.

The *articular surface*, situated between and somewhat below the condyles, is smooth, transversely elongated, and divided by an oblique antero-posterior furrow into a greater and smaller head, or trochlea, of which the former is internal, and the latter external.

The *greater trochlea* is elongated and convex from before backward, but concave from side to side, presenting a genuine pulley-like surface, whose internal border, however, is much more prominent than the external. The greater sigmoid notch of the ulna corresponds to this surface. The *smaller trochlea*, more properly a *head*, is oblong in an antero-posterior direction, but regularly convex for articulation with the cup-like cavity of the radius.

The *coronoid*, or *anterior sigmoid cavity*, is a small depression upon the anterior surface of the bone immediately above the trochlea. It is intended for the reception of the coronoid process of the ulna in flexion of the forearm.

The *olecranoid*, or *posterior sigmoid cavity*, is situated upon the posterior aspect of the bone directly opposite the preceding, from which it is separated by a thin bony septum which is often incomplete. It is quite large, and receives the olecranon of the ulna in extension of the forearm.

The humerus is like all other long bones in the arrangement of its cancellated and compact substance. It is developed from seven ossific points, one for the shaft, the head, the greater tuberosity, and one for each of the condyles and the heads. The point for the shaft appears about the thirty-fifth or fortieth day of fœtal life, and at birth this part of the bone is almost completed, but the different points are not entirely consolidated until the fifteenth or twentieth year.

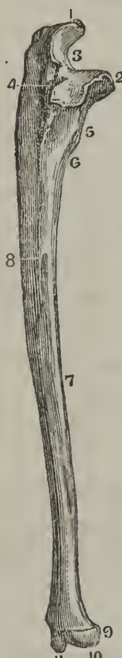
THE FOREARM.

The forearm is situated between the arm and hand; it consists of two long bones, the ulna and radius, which are placed side by side, the former internal and the latter external.

The ULNA is long, unsymmetrical, larger above than below, slightly twisted upon its axis, and curved a little forward.

The *shaft* or *body* of the bone is triangularly prismatic, and presents therefore, three surfaces, which gradually narrow from above downward, in correspondence with the diminishing size of the bone. The *anterior* surface is smooth, slightly concave from side to side, and marked in its upper third by the nutritious foramen, which penetrates obliquely upward; the *posterior* also smooth, but somewhat convex, is traversed throughout its whole length by a blunt ridge for the attachment of muscles, and, in its superior part, by an oblique line, which marks off a small triangular surface for the insertion of the anconeus muscle; the *internal* is smooth and somewhat depressed above, but rounded below where it is almost subcutaneous. The three *borders* separating these surfaces are all more prominent above than below; the *external* is the sharpest, presents towards the radius, and gives attachment to the inter-osseous membrane; the *anterior*, smooth and rounded above, becomes rough below, where it terminates in the styloid process; the *posterior*, which is bifurcated at its commencement and quite prominent in the upper third of the bone, gradually subsides, and is entirely wanting below.

Fig. 94.



Lateral view of the right ulna. 1. Olecranon process. 2. Coronoid process. 3. Greater sigmoid cavity. 4. Lesser sigmoid cavity. 5. Tubercle of the ulna for attachment of brachialis anticus muscle. 6, 7. Angle for the interosseous ligament. 8. Nutritious foramen. 9. Articular face for the radius. 10. Head of the ulna. 11. Styloid process.

The *superior extremity* of the ulna is the largest part of the bone, and presents two large processes called the olecranon and coronoid, and two articular excavations named the greater and lesser sigmoid notches.

The *olecranon* is situated superiorly and a little posteriorly, and is, in fact, the continuation of the shaft of the bone. Its anterior surface forms a part of the greater sigmoid notch, is smooth and concave, and divided into two unequal parts by a vertical ridge, which terminates above by a pointed extremity received into the olecranoid cavity of the humerus; its posterior surface is irregularly convex, smooth above, and rough below for the insertion of the triceps muscle. The *coronoid process* is situated below and anterior to the olecranon, from which it is separated by the articular cavity. It is flattened

from above downward, and presents a *superior* and an *inferior surface*, the former smooth and articular, the latter rough for the insertion of the anterior brachial muscle. It has two *borders*, an *internal*, which is uneven for the insertion of ligaments, and an *external* marked by a smooth, shallow, antero-posterior excavation, which is called the *smaller sigmoid cavity*, and articulates with the circumference of the head of the radius. The *greater sigmoid notch* is situated between the olecranon and coronoid processes, and, when viewed in profile, resembles the letter C. Its surface is smooth and divided into two lateral parts by the vertical ridge, which corresponds to the groove on the trochlea of the humerus. At the bottom of the notch the union of the coronoid and olecranon processes is marked by a transverse line or groove.

The *inferior* or *carpal extremity* is small and formed into a rounded head, which presents two articular surfaces; one is circular, slightly convex, and looks directly downward for contact with the fibro-cartilage that separates it from the cuneiform bone; the other situated upon the external side of the head, is oblong from before backward, smooth, and convex for articulation with the lower extremity of the radius. From the inner side of the head, the *styloid process*, a small but well-marked cylindrical eminence nearly half an inch in length, projects vertically downwards for the attachment of the internal lateral ligament of the wrist-joint. Upon the outer and posterior side of the root of this process is a considerable groove separating it from the articular surfaces.

The ulna articulates with the humerus, radius, and cuneiform bone. Its structure is similar to that of the long bones, in general. It is developed from three points, one for the shaft and one for each extremity. There is no separate ossific point for the coronoid process.

The RADIUS is situated upon the outer side of the ulna, and is in contact with it above and below, but a broad interval, called the interosseous space, separates the two throughout the rest of their extent. It is a little shorter than the ulna, and, unlike it, larger below than above.

The *body* or *shaft* of the bone is triangular prismatic, slightly curved externally, and presents three surfaces and three borders. The *anterior surface* looks to some extent internally, is broader below than above, and perforated in its upper third by the nutritious foramen. It is terminated superiorly, within about an inch of the

corresponding extremity of the bone, by a large oval eminence called the *bicipital tuberosity*, whose posterior half is rough for the insertion of the biceps muscle, and the anterior smooth for the gliding of its tendon. The *posterior* surface is convex above and below, but depressed at its middle; the *external* is rounded and smooth, except near its middle, where there is a roughness for the insertion of the round pronator muscle. Of the three *borders*, the anterior and posterior are blunt and rounded, but the internal is well-marked, and directed toward the corresponding border of the ulna; it is intended for the attachment of the interosseous fibrous membrane.

Fig. 95.

Posterior view of the right radius. 1. Head of the bone. 2. Annular articulating surface for the ulna. 3. Neck. 4. Tubercle. 5. Nutritious foramen. 6. Insertion of the short supinator muscle. 7. Internal edge for the attachment of the interosseous ligament. 8. Articular face for the ulna. 9. Anti-carpal face of the bone; 10. Styloid process. 11. Grooves made by the extensor tendons in their course to the hand.

The *superior extremity* or *head* represents a short oblique section of a cylinder, whose base looks upward. It is smooth and slightly concave, and articulates with the smaller head of the humerus. The circumference is circular, broadest upon its inner aspect, smooth and convex throughout, and is received by the smaller sigmoid notch of the ulna. Between the head and bicipital tubercle is a slight constriction or *neck*, which is bent a little outward.

The *inferior extremity* is broad and thick, and presents upon its lower aspect a large, concave, triangular articular surface, divided by a very slight antero-posterior ridge into two unequal parts, of which the external corresponds to the scaphoid, and the internal to the semilunar bone. The circumference of the articular surface is marked *anteriorly* by some slight inequalities for the attachment of the anterior ligament of the joint; *posteriorly*, by several vertical and oblique grooves for the tendons of the extensor muscles of the fingers and thumb; *internally*, by a small antero-posterior excavation, called the *semilunar cavity*, for articulation with the side of the head of the ulna; and *externally*, by a short, thick, angular eminence, named the *styloid* process, to which the external lateral ligament of the joint is attached.

The radius articulates with the humerus, the ulna, and the carpus. Its structure is said to differ from that of the ulna in possessing a greater degree of brittleness, especially in the lower third of the bone, where fractures are most apt to occur. It is developed from three points of ossification, namely, one for each extremity, and one for the shaft; the last precedes that of the ulna by two or three days, appearing from the thirty-fifth to the fortieth day. The bone is not completed, however, before the ninth or tenth year.

THE HAND.

The hand consists of three parts, the carpus or wrist, the metacarpus, and the fingers. In studying its different bones the palmar surface is considered as presenting forward, although the natural position is midway between pronation and supination. In this position it has an anterior or palmar, and a posterior or dorsal surface, an external or radial, and an internal or ulnar border, a carpal, and a digital extremity.

The CARPUS or WRIST is situated between the forearm and the metacarpus, and consists of eight small and closely articulated bones. It is flattened from before backward, quadrilateral, transversely elongated, and presents two surfaces and four borders. The *anterior surface* is transversely concave for the lodgement of the tendons of the flexor muscles of the fingers, the borders of the concavity being formed, in a great measure, by two eminences on each side, which give attachment to the annular ligament. The *posterior surface* is slightly convex, and marked only by the lines indicating the union of the several bones. The *superior border* is convex and smooth, and corresponds to the lower extremity of the forearm; the *inferior*, longer than the superior, is irregular, and presents five smooth facets for articulation with the five metacarpal bones; the *external* or *radial*, and the *internal* or *ulnar border*, are each short and uneven, and give attachment to ligaments.

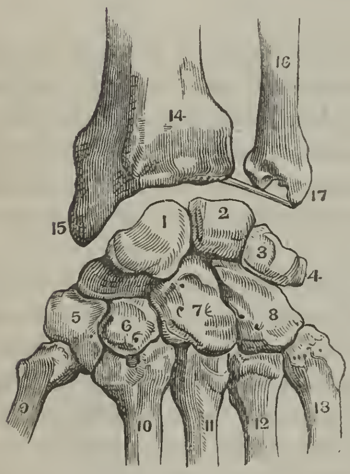
When joined together the eight bones are found to form two transverse rows, each consisting of four bones, named as follows:—

First or upper row, commencing at the radial border . . . .
1. The scaphoid.
2. The semilunar.
3. The cuneiform.
4. The pisiform.

Second or lower row, commencing at the radial border	1. The trapezium. 2. The trapezoid. 3. The magnum. 4. The unciform.

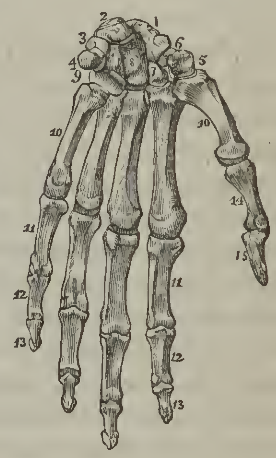
The METACARPUS is a sort of osseous grating situated between the carpus and the fingers, and forming the central square part of the hand. It is quadrilateral in shape, broader below than above, concave in front, convex behind, and consists of five separate bones

Fig. 96.



Posterior or dorsal surface of the left wrist and contiguous bones. 1. Scaphoid bone. 2. Semilunar. 3. Cuneiform. 4. Pisiform. 5. Trapezium. 6. Trapezoid. 7. Magnum. 8. Unciform. 9. Metacarpal bone of the thumb. 10. Same of the index finger. 11, 12, and 13. Third, fourth, and fifth metacarpal bones. 14. Radius. 15. Its styloid process. 16. Ulna. 17. Its styloid process.

Fig. 97.



The hand viewed upon its anterior or palmar aspect. 1. The scaphoid bone. 2. The semilunar. 3. The cuneiform. 4. The pisiform. 5. The trapezium. 6. The groove in the trapezium that lodges the tendon of the flexor carpi radialis. 7. The trapezoid. 8. The magnum. 9. The unciform. 10, 10. The five metacarpal bones. 11, 11. The first row of phalanges. 12, 12. The second row. 13, 13. The third row, or ungual phalanges. 14. The first phalanx of the thumb. 15. The second and last phalanx of the thumb.

called metacarpal, designated numerically, which are first, second, &c., counting from without. With the exception of the first, these bones are placed nearly parallel, side by side, and joined together at their two extremities, but separated in the middle by spaces which lodge the interosseous muscles. They belong to the class of long bones, and consist each of a body and two extremities.

The body is triangular prismatic, and curved so as to present a con

cavity in front and a corresponding convexity behind. The *upper extremity* is thick and wedge-shaped, broader behind than before, and presents a superior surface for articulation with the carpus, two lateral surfaces for contact with the bone on each side, and an anterior and a posterior rough surface for the attachment of ligaments. The *lower extremity* or *head* is oblong from before backward, smooth, convex, flattened laterally, and of greater extent before than behind; upon each side of its lateral surfaces is a rough concavity for ligamentous attachment. The *first metacarpal bone* belongs to the thumb, and is placed upon a plane somewhat anterior to the others from which it diverges outwardly, leaving a large triangular-shaped interosseous space between it and the next. Its separate position is connected with the opposition of the thumb in reference to the rest of the hand. It is the shortest and thickest of the group; its body is flattened from before backward; its carpal extremity is smooth, concave from before backward, but convex transversely, corresponding thus to the surface upon the trapezium which is concave and convex in the reverse order.

The *second and third metacarpal bones* are distinguished from the others by their greater length, and from each other by the greater size of the third. They may be known also by their carpal extremities; that of the second presents two articular surfaces above, one for the trapezium, and a much larger one for the trapezoid, and but one lateral facet, while the third has two of the latter and but one above for the magnum.

The *fourth and fifth metacarpal bones* are much shorter and smaller than the second and third. The fourth has two articular surfaces above for the magnum and unciform, two circular facets for contact with the third, and one for the fifth metacarpal bone. The fifth joins the unciform by a concave surface, and the fourth by a single plane lateral facet; upon its ulnar side it presents a tubercle for the insertion of the ulnar extensor muscle of the hand.

The FINGERS are known anatomically by their number, first, second, &c., counting from the radial side. The ordinary appellations are, thumb, index or indicator, middle finger, ring finger, and articular or little finger.

Each finger, excepting the first, consists of three bones called phalanges, which are placed in a line with each other, and diminish successively from the first to the third. The thumb has but two. Like other long bones, they have a body and two extremities.

The *first phalanges*, five in number, are each semicylindrical, and

curved so as to present a slight concavity in front, where they are also grooved lengthwise for the lodgement of the extensor tendons of the fingers. A rough edge on each side of this groove gives attachment to the fibrous sheath which confines the tendon. Posteriorly, they are convex and smooth. The superior extremities are transversely oval, and slightly excavated for articulation with the heads of the metacarpal bones. The inferior extremities, smaller than the superior, present a smooth pulley-like surface, prolonged farther upon the anterior than the posterior aspect for articulation with the second row, and a rough depression on each side for the attachment of ligaments.

The *second phalanges*, four in number (the second of the thumb belonging to the third class), are shorter and smaller than the first, but not unlike them in shape. The bodies are curved forward, convex behind, concave and grooved in front. The superior extremities, transversely elongated, present two small articular excavations separated by an antero-posterior ridge, corresponding to the pulley-like surfaces of the preceding group. The inferior extremities are like the inferior extremities of the first row, only smaller.

The *third* or *last phalanges*, five in number, called also *ungual*, because they support the nails, are much shorter than the others, of a pyramidal form, flattened from before backward, and constricted at the middle. They are convex behind, nearly plane in front, and present a rough margin at the summit. Their bases or superior extremities are elongated transversely, and present articular surfaces in every respect resembling those of the second row. The ungual phalanx of the thumb is the largest of the series.

Development of the Bones of the Hand.—1. The *carpus* is entirely cartilaginous at birth, and does not usually begin to ossify until about the end of the first year, when a single ossific point appears in the magnum. This is very soon succeeded by a point in the unciform; next, during the third year, in the cuneiform; then, during the fifth year, in the trapezium and semilunar; and, about the eighth year, in the scaphoid and trapezoid. The pisiform is the latest of all the bones of the skeleton in ossifying, no bony matter being deposited in it before the twelfth year. 2. The *metacarpal bones* are each developed from one principal point of ossification, which makes its appearance in the body of each bone about the fortieth or fiftieth day. About the third year an epiphysary point appears upon the lower end of each (excepting that of the thumb),

which becomes united to the body towards the twentieth year. The metacarpal bone of the thumb has also an epiphysis superadded upon its superior or carpal extremity. 3. The *phalanges* are also developed from one principal and one epiphysary point, the former appearing in the body of each about the same time as in the metacarpal bones. The epiphysary point is developed upon the upper extremities of each (as in the metacarpal bone of the thumb) about the third or fourth year in the first row, and a year later in the others. Entire union does not take place before the eighteenth or twentieth year.

THE INFERIOR EXTREMITIES.

The skeleton of the inferior extremities presents many very striking analogies to that of the superior; it is, indeed, constructed upon the same general plan with certain modifications having reference to the different functions of the limb. Like the latter, it consists of four divisions, namely, the hip or haunch, the thigh, the leg, and the foot, corresponding to the shoulder, arm, &c.

The first of these divisions, the hip, unlike its counterpart, the shoulder, is composed, in the adult, of but one bone, the innominate, which, however, in the young subject consists of three parts.

THE INNOMINATE BONE.*

The innominate or hip-bones, one upon each side, form the lateral and anterior walls of the pelvis. They belong to the class of broad bones of which they are the largest in the body, and most irregular.

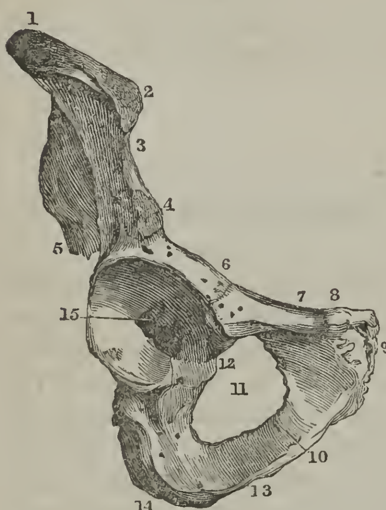
In the young subject each bone consists of three parts, called, respectively, the ilium, pubis, and ischium; and, for convenience of study and reference, it is customary to retain these divisions after their entire union has taken place.

The ILIUM, which forms the upper and lateral flaring part of the pelvis, is the largest and broadest of the three pieces. It is triangular, and presents two surfaces, three borders, and three angles.

* *Os innominatum,* the nameless or unnamed bone, so called from its want of resemblance to any known object. Also *os coxæ,* from *coxa,* the haunch.

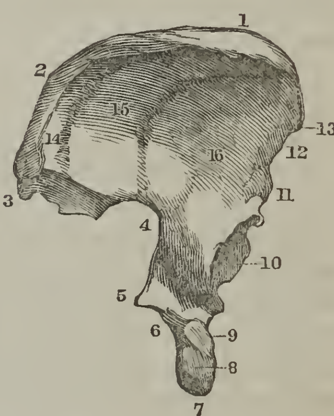
The *internal surface* is for the most part smooth and concave; it forms what is called the *iliac fossa*, and is occupied by the iliac muscle. On account of the outward inclination of the ilium this fossa looks obliquely upward and inward, and is bounded below by a prominent horizontal angle named the *ilio-pectineal line or ridge*,

Fig. 98.



Front view of the right innominate bone. 1. Crest of the ilium. 2. Anterior superior spinous process. 3. Interspinous notch. 4. Anterior inferior spinous process. 5. Posterior inferior spinous process. 6. Ilio-pectineal eminence. 7. Continuation of the ilio-pectineal line. 8. Spinous processes of the pubis. 9. Symphysis of the pubes. 10. Junction of the rami of the pubis and ischium. 11. Thyroid or obturator foramen. 12. Cotyloid notch. 13. Ramus of the ischium. 14. Ischiatic tuber. 15. Acetabulum, with the fossa in its bottom.

Fig. 99.



Lateral view of the right innominate bone. 1. Iliac crest. 2. Posterior superior spinous process. 3. Posterior inferior spinous process. 4. Great sciatic notch. 5. Spine of the ischium. 6. Trochlea for the internal obturator muscle. 7. Ischiatic tuber. 8. Rough surface for the origin of the biceps and semi-tendinous muscles. 9. Surface for the origin of the semi-membranous muscle. 10. Acetabulum. 11. Anterior inferior spinous process. 12. Interspinous notch. 13. Anterior superior spinous process. 14. Origin of the great gluteal muscle. 15. Origin of the middle gluteal. 16. Origin of the small gluteal.

which separates the ilium from the ischium, is continued forward upon the pubis, and forms the border of the superior strait of the pelvis. (See Fig. 102, 7.) Immediately above the middle of this line is a nutritious foramen. Behind the fossa is a large, rough, irregular *auricular surface*, presenting inward and a little forward for articulation with the sacrum. Immediately back of this surface occupying a space about an inch in breadth, are numerous rough

eminences and depressions for the attachment of the sacro-iliac ligaments.

The *external* or *dorsal surface* is convex before and behind, and slightly concave in the middle. It is traversed in an antero-posterior direction by two faintly marked curved ridges, called the *superior and inferior curved lines*, which, commencing respectively at the superior and inferior spinous processes of the anterior margin, arch upward and terminate upon the inferior border of the bone behind. The space between these two lines is occupied by the inferior gluteal muscle, and that between the inferior one and the hip-joint by the capsular ligament. Upon the upper posterior part of the dorsum may be observed another but much shorter rough line, directed from above downward, and marking off a small uneven surface (represented too large upon Fig. 98) for the attachment of a part of the great gluteal muscle. The entire space in front of this and above the superior curved line gives attachment to the middle gluteal muscle. Below the inferior curved line is a nutritious foramen.

The *superior border* or *crest* of the ilium is nearly semicircular, and, when looked at from above, appears bent somewhat like the italic letter *S*. It is rough and thick, and narrower at the middle than at the two extremities. It is divided into an internal and an external lip, and an interspace, for the attachment of the three lateral broad muscles of the abdomen.

The *posterior border* looks downward as well as backward. It commences at the posterior termination of the crest by an eminence called the *superior posterior spinous process*, below which is a slight notch, and then another eminence, the *inferior posterior spinous process*, and then another much larger excavation which enters into the formation of the *great sacro-ischiatic notch*. The *anterior border* commences at the anterior extremity of the crest, and forms with it a rounded angle called the *superior anterior spinous process;* beneath this is a large superficial notch terminating in another eminence, denominated the *inferior anterior spinous process*; below the last is a smaller but deeper notch, which is bounded inferiorly by a large rounded eminence, marking the union between the pubis and ilium, and hence called the *ileo-pectineal eminence.*

The anterior inferior angle of the ilium joins the pubis and ischium, and forms nearly two-fifths of the wall of the acetabulum.

The PUBIS forms the anterior and inner part of the innominate bone; it consists of two portions, one superior and horizontal, called

the body, and the other, inferior and vertical, termed the ramus or branch.*

The *body* is thick, triangular prismatic, and horizontal; the base is continuous with the ilium and ischium, and the apex with the ramus. The *superior surface* is slightly depressed, and gives origin to the pectineus muscle; the *internal* is smooth and rounded, and presents toward the cavity of the pelvis; the *inferior* is grooved obliquely forward and inward, for the obturator vessels and nerve, and forms the upper boundary of the obturator foramen.

Of the two *superior borders*, the *posterior* is formed by the continuation of the ilio-pectineal ridge, which terminates near the inner extremity of the bone in a well-marked eminence called the *spinous process*. Running off from this process backward and outward, toward the acetabulum, is the rounded *anterior border*. The *inferior border* is situated below and behind, and is notched by the obturator groove.

The *base* or *external extremity* is the thickest part of the bone; it joins above with the ilium, below with the ischium, and, between these two points, is excavated for the acetabulum of which it forms about one-fifth.

The *apex* or *internal extremity* is expanded, flattened from before backward, smooth internally where it corresponds to the urinary bladder, and rough anteriorly for the attachment of muscles. Its inner surface is vertical, oblong from above downward, and unites by fibro-cartilage with the corresponding part of the opposite bone to form the *symphysis of the pubes*. Between the symphysis and the spinous process, upon the upper aspect of the bone, is a slightly raised oblique ridge called the *pubic crest*.

The *branch* or *ramus* of the pubis is continued downward from the inner extremity of the body to join the ischium. It is very short, flattened from before backward, smooth posteriorly, and rough in front; its external border is thin and sharp, and forms part of the margin of the obturator foramen; the internal is thick and rough, and constitutes with its opposite fellow the highest part of the pubic arch.

The ISCHIUM is situated below the ilium and pubis. It consists of a body and branch, united so as to form behind a thick, rough, and rounded angle called the *tuberosity*.

The *body* is situated behind; it is short, thick, and triangular

* The term *body* is used by some anatomists to indicate only the expanded part of the bone formed by the union of the horizontal and vertical portions.

prismatic, and presents three surfaces; the *internal* is smooth and concave, and forms part of the cavity of the pelvis; the *external* is rough for the attachment of muscles; and the *posterior* is convex and also rough for the insertion of the greater sacro-ischiatic ligament.

The *anterior border* is thick and forms part of the margin of the obturator foramen; the *external* is rounded and depressed superiorly for the origin of the semi-membranous muscle; the *internal* is divided into two parts by a prominent pointed process (*spinous process of the ischium*), which is directed backward and outward, and gives insertion to the smaller sacro-ischiatic ligament. Above this process the margin is sharp and well-defined, and forms with the inferior border of the ilium the *greater sacro-ischiatic notch*, which is converted into a foramen in the recent state by the ligament already mentioned. Below the process the margin presents a small smooth and rounded notch (*smaller ischiatic notch*), upon which the tendon of the internal obturator muscle glides as upon a pulley; this is also converted into a foramen in the recent state, and, beside the tendon just mentioned, transmits also the internal pudic artery, vein, and nerve.

The *superior extremity* joins the ilium and the pubis, and forms about two-fifths of the acetabulum; the *inferior* is continuous with the branch at the tuberosity.

The *branch* or *ramus* of the ischium is much smaller than the body, and directed upward and inward to join the branch of the pubis. It is triangular prismatic, rough anteriorly for muscular attachment, smooth posteriorly, and rounded and uneven internally, where it forms with the branch of the pubis one of the sides of the pubic arch. Its external border is sharp for the attachment of the obturator membrane; the two others present nothing special.

The *acetabulum*, or, as it also called, the *cotyloid cavity*, receives the head of the thigh bone; it is situated upon the external surface of the innominate bone, a little below its middle, at the junction of the three pieces. Each part of the innominate bone contributes to its formation, the ilium nearly two-fifths, the pubis one-fifth, and the ischium a little more than two-fifths. Its nearly hemispherical cavity is about two inches in diameter and nearly one in depth, and looks outward, forward, and downward. Its border is prominent and sharp, especially above, and, in the recent state, is made still more projecting by a ring of fibro-cartilage which rests upon it. In front, this border presents a deep notch, which, in the fresh state, is formed into a foramen by a transverse ligament, and gives passage to the

vessels of the joint. At the bottom of the cavity there is a rough depression, which is continuous with the notch for the attachment of the round ligament of the joint, and the lodgement of certain little masses of fat.

The *obturator* or *thyroid foramen* is the large opening formed by the pubis above, and the two parts of the ischium below. It is vertically oval in shape in the male, but triangular in the female. It is nearly closed in the recent state by a strong fibrous membrane. Its margin is thin and sharp, and grooved superiorly for the obturator vessels and nerve.

The innominate bone articulates with its fellow of the opposite side, with the sacrum, and with the femur. Like other broad bones, it consists of two laminæ of compact tissue inclosing a diploic or cellular substance. In some places this latter constituent is almost entirely wanting, and the two laminæ come in contact; it is most abundant around the acetabulum and along the crest of the ilium.

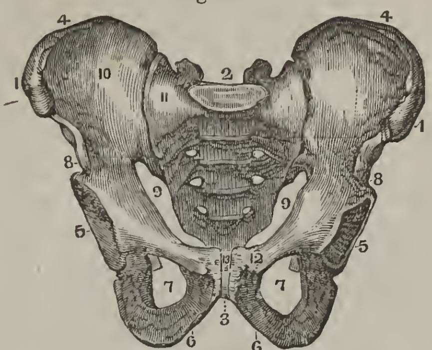
The innominate bone is developed from three principal ossific points corresponding to the three pieces; the first appears in the ilium about the fiftieth or sixtieth day, the second in the body of the ischium towards the third month, and the third in the horizontal portion or body of the pubis during the fourth or fifth month. These unite together at the acetabulum about the thirteenth or fourteenth year, a small Y-shaped piece of bone being developed separately between the three just before this period. At birth, the crest of the ilium, the acetabulum, the tuberosity and ramus of the ischium, and the inner extremity of the pubis, are almost entirely cartilaginous. About the thirteenth or fourteenth year four epiphyses begin to show themselves upon the different parts of the bone; namely, one for the whole length of the crest of the ilium, one for the anterior inferior iliac spine, one for the broad surface of the tuberosity of the ischium, and one for the inner extremity of the pubis. These are all united about the twentieth, or sometimes not until the twenty-fifth year.

THE PELVIS.

The bony pelvis is a large, irregular, broad ring forming the inferior part of the skeleton of the trunk, connected on the one hand with the spinal column which rests upon the middle of its superior margin behind, and on the other, with the two thigh bones whose heads are received into the cotyloid cavity on each side. It is com-

posed of four separate bones, namely, the sacrum, the coccyx, and the two innominate bones, to which some anatomists add also the

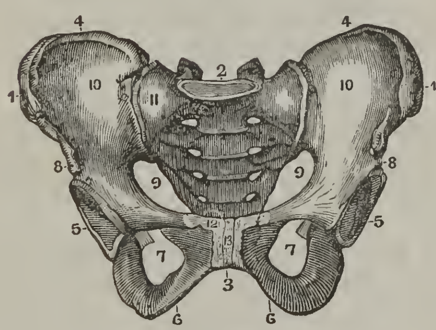
Fig. 100.



MALE PELVIS.

last lumbar vertebra. It is proportionally smaller in the child than in the adult, and, owing to characteristic differences in its separate

Fig. 101.



FEMALE PELVIS.

The male and female pelvis are compared in Figs. 100 and 101. 1. Anterior superior spinous process of the ilium. 2. Base of the sacrum. 3. Angle of the pubis. 4. Crest of the ilium. 5. Acetabulum. 6. Ramus of the ischium. 7. Thyroid or obturator foramen. 8. Anterior inferior spinous process of the ilium. 9, 9. The superior strait. 10. Iliac fossa. 11. Sacro-iliac symphysis. 12. Spine of the pubis. 13. Symphysis of the pubes.

pieces, is larger and more expanded in the female than in the male. For its obstetric characters, the student is referred to works upon midwifery.

Considered as an irregular hollow cone with its base looking upward and forward, and its summit truncated and bent forward, the pelvis has an external and an internal surface, which should be sepa-

rately considered. The *external surface* is marked *in front*, in the middle line by the union of the two pubic bones forming the *pubic symphysis*, which is always longer in its vertical direction in the male than in the female, measuring one and three-quarter inches in the former, and one and a quarter in the latter. Below the symphysis the branches of the pubes and ischia diverge to form the *arch of the pubis*, which is larger in the female than in the male. Outside of the arch on each side is the obturator foramen, vertically oval in the male, but larger and triangular in the female. *Posteriorly*, in the median line, is the vertical spine of the sacrum terminating below in a bifurcation, which forms the two sides of the lower orifice of the spinal canal. Outside of the spine are the sacral grooves with the sacral foramina, and, still more externally, the projecting border of the ilium. *Laterally*, may be observed the broad uneven dorsal surface of the ilium, with its semicircular lines and nutritious foramen, the acetabulum, and the sacro-ischiatic notches; the latter, when the ligaments that extend from the side of the sacrum and coccyx to the tuberosity and spine of the ischium are in place, constitute the greater and smaller sacro-ischiatic foramina.

The *internal surface* of the pelvis is divided into two parts by the ilio-pectineal lines and the promontory of the sacrum; the superior division is called the *greater* or *false*, and the inferior the *smaller* or *true pelvis*.

The *greater* or *false pelvis* is formed behind by the last lumbar vertebra, and laterally by the internal concave surfaces of the iliac bones, which are more flaring and less concave in the female than in the male. In front, the walls are deficient.

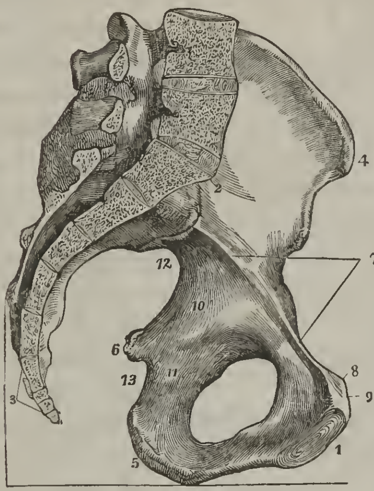
The *smaller* or *true pelvis* is a curved cylindrical canal, whose two extremities are cut, as it were, in such a manner that the posterior is much longer than the two lateral walls, and the anterior less than either. The superior is called the inlet or superior strait, and the inferior, the outlet or inferior strait of the pelvis. The intervening cavity is improperly called the pelvic excavation.

The *superior strait* or brim of the pelvis is an irregular circle in the male and a transverse oval in the female, and is defined, behind, by the promontory, and expanded wings or shoulders of the sacrum, laterally, by the ilio-pectineal line, and, in front, by the crest and symphysis of the pubes. The opening is smaller in the male than in the female. In the latter, the *antero-posterior diameter*, extending from the pubic symphysis to the anterior edge of the base of the sacrum, is about four inches, the *transverse* about five, and

the *oblique*, reaching from the acetabulum of either side to the sacro-iliac junction of the opposite side, about four and a half inches. In the living subject the transverse diameter is shortened nearly an inch by the encroachment of the iliac muscles.

The *plane* of the superior strait (Figs. 102 and 103) is not horizontal, but forms, with the axis of the body above, an angle of 145°.

Fig. 102.



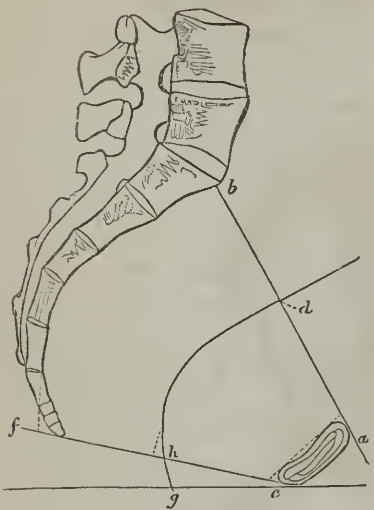
A vertical section of a female pelvis made through the symphysis of the pubes and the middle of the sacrum, and showing the left lateral half (reduced from Naegele's figure). 1. Symphysis of pubes. 2. Base of sacrum. 3. Coccyx. 4. Anterior superior spine of ilium. 5. Tuberosity of ischium. 6. Spine of ischium. 7. Ilio-pectineal line. 8. Spinous process of the pubis. 9. Crest of the pubis. 10. Superior inclined plane. 11. Inferior inclined plane. 12. Great sacro-ischiatic notch. 13. Small sacro-ischiatic notch.

The *axis* of this strait, a line drawn perpendicular to the centre of the plane, if continued upward, would pass through the abdominal wall at the umbilicus, and, if extended downward, would strike the apex of the sacrum or the first bone of the coccyx.

The *inferior strait* of the pelvis is nearly circular, but deeply notched on each side and in front. The lateral notches are the sacro-ischiatic which are bridged across, in the recent state, by the sacro-ischiatic ligaments; the anterior is the pubic arch, which is broader and less angular in the female than in the male. The diameters of this strait in the female are: 1, the *antero-posterior*, extending about four inches from the lower margin of the pubic symphysis to the point of the coccyx, but capable of being increased at least half an inch in the living subject by the mobility of the last bone; 2, the *transverse*, extending between the tuberosities of the ischia, also four

inches; 3, the *oblique* measuring four inches from the junction of the ramus of the ischium and pubis to the middle of the sacro-ischiatic ligament of the opposite side, and susceptible of a slight increase in the living subject. The *plane* of the inferior strait of the dry pelvis is marked by a line, which runs from the lower margin of the pubic symphysis to the point of the coccyx. Its course is downward and a little backward, the summit of the coccyx, in the natural position of the pelvis, being a little higher than the inferior edge of the symphysis.

Fig. 103.



A vertical section in outline of the pelvis at its middle, with lines indicating the axis of the pelvis and a horizontal line below the figure.

The *pelvic cavity* is bounded behind by the anterior surface of the sacrum and coccyx, laterally, by the ischia, and anteriorly, by the two pubic bones and their symphysis. The *posterior* wall is about four inches and a half in height, and concave, the concavity being, probably, a little greater in the male than in the female; upon it may be seen the transverse lines and foramina of the sacrum, and the transverse divisions between the separate pieces of the coccyx. The *anterior* wall is smooth, and slightly convex from above downward; it varies from one and a quarter to one and two-third inches in height in the median line.

The *lateral walls* correspond to the inner surface of the acetabula, the ischia, and the obturator foramina. They are about four inches in height, and converge slightly from above downward. Each of these lateral walls is traversed obliquely from the superior extremity of the posterior margin of the obturator foramen to the spine of the ischium, by a raised line or ridge, which marks off two inclined surfaces, one superior and posterior, the other anterior and inferior (Fig. 102; 10, 11). They are better marked in the female, and more important on account of their influence upon the movements of the head of the child in parturition.

THE FEMUR.

The femur, situated between the pelvis and the tibia, is the longest and largest bone of the skeleton. Its direction is not vertical, but oblique from above downward and inward, the obliquity being greater in the female than in the male on account of the greater breadth of the female pelvis.

The *shaft* of the bone is curved, with the convexity presenting forward, slightly twisted upon its axis, and in shape irregularly prismatic. Like most of the other long bones, it is smaller, harder, and more brittle in its middle than anywhere else. At this point the body is nearly cylindrical, and, below, rather flattened from before backward; the prismatic form is well marked above. It is described as having anterior, external, and internal surfaces.

The *anterior surface* is convex, both in a vertical and transverse direction, smooth, and broader above and below than in the middle; it follows the twist of the bone, and inclines a little outward superiorly, and inward below.

The *external surface* is somewhat broader than the anterior, smooth, and slightly excavated above, but convex below. The *internal surface* is smooth and almost flat, and presents nearly backward at its inferior part, where it is also broader than it is above. Of the three *edges* limiting these surfaces, the *internal* and *external* are smooth and rounded, but the posterior forms a prominent *rough line* (*linea aspera*), extending nearly the whole length of the bone. Above and below this line bifurcates, and, in the rest of its extent, is divided into an internal and an external lip, and an interspace for the attachment of muscles. The external branch of the superior bifurcation is very rough, and passes off to the great trochanter, and the internal, to the small trochanter. The two branches of the inferior bifurcation terminate, respectively, on the back part of the internal and external condyles. Between them is a large, flat, triangular surface, which corresponds to the popliteal space or ham of the thigh. In the lower part of the rough line, about the junction of the inferior third with the upper two-thirds of the bone, is the nutritious foramen, which penetrates from below upward and forward.

The *superior extremity of the femur* is somewhat flattened antero-

posteriorly, and presents a large articulating process divisible into a head and neck, and two non-articular eminences called trochanters.

The *articulating process* is placed upon the inner aspect of the bone, and directed obliquely upward, inward, and a little forward, its axis forming with the shaft below an obtuse angle, the degree of which varies in different individuals.*

The *head*, which constitutes the summit of the process, is smooth and convex, more extensive above than below; it somewhat exceeds a hemisphere, and is marked a little below its middle by a rough depression for the attachment of the round ligament. In the recent state, it is covered with cartilage and received into the cotyloid cavity of the innominate bone. The *neck* is cylindrical but flattened from before backward, so that a transverse section represents an oval, broader above than below, whose vertical axis exceeds the transverse by at least one-third. Posteriorly and inferiorly, the neck is much longer than it is anteriorly and superiorly; its line of union with the shaft is marked *in front* towards the small trochanter, by a rough surface, to which the capsular ligament of the joint is attached; *above*, by the root of the great trochanter; *below*, by the small trochanter; and *behind*, by a projecting ridge connecting these two eminences, and hence called the *inter trochantine line.*

Fig. 104.

Front view of the right femur. 1. Head of the bone. 2. Depression for the round ligament. 3, 4. Neck. 5. Great trochanter. 6. Small trochanter. 7, 8. Shaft. 9. External condyle. 10, 11. Articular faces for the tibia. 12. Trochlea for the patella. 13. Internal condyle.

The *great trochanter* is placed externally to the head and neck, and upon a line with the shaft of the bone. It is large, quadrangular, vertically prominent, but upon a little lower level than the head, subcutaneous, and rough, for the attachment of muscles. Its external surface is irregularly convex, and covered by the great gluteal muscle, but may always be readily felt

* In some persons, especially females and old persons, it is almost a right angle.

through the skin; its internal surface is excavated so as to form a pit or fossa (trochantine pit), into which the tendon of one of the rotator muscles of the thigh is inserted. Its relations with the crest of the ilium, the external condyle, and the external malleolus, require particular notice on account of the aids they furnish in the diagnosis of injuries of this part of the body.

The *small trochanter* is a prominent conoidal eminence of much less size than the preceding, situated just below and a little behind the neck of the bone, and directed backward and inward; it is also intended for the insertion of muscles.

The *inferior extremity* is very large, more particularly in a transverse direction, and is shaped somewhat like the clenched fist, with the middle and ring fingers separated. Its lower surface is divided by a broad deep notch behind, and a shallow groove in front, into two smooth, convex, articular eminences, called *condyles*, of which the external is the larger and more nearly upon a line with the shaft of the bone, and the internal longer, narrower, and inclined from above a little inward. When the bone is held perpendicularly, the internal will be seen to project a little below the other; but in its natural oblique position, both condyles rest upon a horizontal plane surface. In front of the notch the condyles unite to form a smooth pulley-like surface for articulation with the patella, which extends a considerable distance upward upon the anterior aspect of the bone. The external margin of this trochlear surface is much more prominent than the internal, which accounts, in part, for the more frequent dislocation of the patella inward. The lateral surfaces of the condyles are rough, perforated by numerous vascular foramina, and marked by a small well-defined eminence or tuberosity, for the attachment of the lateral ligaments of the knee-joint. The internal of the two is the more prominent, and is situated just in front of a depression that gives origin to the popliteal muscle.

The femur articulates with the innominate bone, the tibia, and the patella.

Structure.—A longitudinal section of the femur presents a large medullary canal, surrounded by dense compact tissue in the shaft of the bone, which becomes gradually open and cellular toward the extremities. The neck and head consist of a thin lamina of compact tisssue, inclosing a tolerably close cellular or spongy tissue. The fibres of the tissue have been lately demonstrated by Prof. Wyman to belong to two classes; the one diverges from the lower part of the neck toward the head and great trochanter, the other extends in

parallel curves from the base of the great trochanter to those of the preceding class that support the upper surface of the head, and to the shell of compact tissue between these two points.

THE PATELLA.

The patella, or in common language the knee-pan, belongs to the class of sesamoid bones, of which it is the largest in the body. It is situated in front of the knee-joint, is irregularly oval in shape, flattened from before backward, and presents two surfaces and a circumference.

The *anterior surface* is convex, marked by numerous small vertical ridges and furrows indicating the direction of the osseous fibres, and perforated by numerous nutritious foramina, which for the most part penetrate from below upward. In the recent state, this surface is covered by an expansion of the tendon of the extensor muscles of the leg, whose fibres are closely attached to the grooves and ridges, and continuous with the ligament of the patella below. The *posterior* or *articular surface* is divided by an oblique ridge into two lateral concave parts, of which the external is the larger; they correspond to the anterior surface of the condyles of the femur, and, in the recent state, are incrusted with cartilage, and covered by the synovial membrane of the joint. The *superior* and *lateral borders* are thick and rounded, especially the former; the inferior is prolonged downward into an angular process, whose posterior aspect is rough, for the attachment of the ligament that connects the bone to the tibia.

Fig. 105.

Front view of the patella.

The patella consists almost entirely of spongy tissue, a very thin layer of compact substance covering its exterior. A vertical section exhibits a well-marked fibrous arrangement of its component parts in the longitudinal or vertical direction, which accounts for the more frequent fracture of this bone in this direction.

The patella is developed from a single ossific point which makes its appearance in the common tendon of the extensor muscles of the leg about two and a half years after birth.

THE LEG.

The leg, like the forearm, consists of two bones, the tibia and fibula. They are placed side by side, but separated, except at their extremities, where they are articulated by a long narrow interspace, which is occupied, in the recent state, by a strong fibrous interosseous membrane.

Fig. 106.

Front view of the right tibia. 1. Central ridge and fossa. 2, 3. Articular surfaces for the femur. 4. External condyle, and immediately below it, the articular facet for the fibula. 5. Tubercle, or tuberosity. 6. Fossa for the anterior tibial muscle. 7. Anterior angle or shin. 8. Shaft, which commences at 6. 9. Articular surface for the fibula. 10. Articular surface for the astragalus 11. Internal malleolus.

The TIBIA is situated upon the inner side of the fibula. Unlike the femur it is vertical, and consequently parallel with its fellow of the opposite limb.

The *shaft* of the bone is remarkable for its uniform and gradual diminution from above downward to within a short distance of the inferior extremity. It is triangular prismatic in shape, especially above, and slightly twisted upon its axis. Of its three surfaces, the *internal* inclines a little forward; it is broad above, where it is covered by the expansion of the tendons of the internal ham-string muscles, but gradually narrows toward the lower part, and is subcutaneous throughout nearly the whole of its extent.

The *external surface*, narrower than the internal, is excavated above for the origin of the anterior tibial muscle, but in the lower two-thirds of its extent is convex, and turned somewhat forward.

The *posterior surface*, is broad above and narrow below, and traversed at its upper part, by a raised line which runs from the external condyle downward and inward, marking off a triangular surface above, which corresponds to the popliteus muscle; immediately below this is the very large nutritious foramen of the bone; with these exceptions this surface is smooth and almost plane. The three *borders* separating the three

surfaces are all well marked; the *anterior*, called the *crest* of the tibia, is subcutaneous. It commences superiorly in a large rough eminence called the *anterior tuberosity* of the tibia, descends a little outwardly, becomes very prominent in the middle third of the bone, and then gradually subsides, making a second curve with the convexity presenting inward; the *internal*, hardly observable above, becomes more prominent below; the *external*, sharp and rough throughout its whole extent, gives attachment to the interosseous membrane.

The *superior extremity* is thick and expanded, and presents a large transversely oval tabular surface for articulation with the femur. Traversing this surface from behind forward to within a short distance of the anterior edge, is a short but thick process or spine, which is bounded in front and behind by two rough depressions for the attachment of the crucial ligaments of the joint.

By this spine and its two terminal depressions, the surface is divided into two shallow lateral excavations for articulation with the condyles of the femur; the internal is the smaller and oval from before backward, and the external is larger, less concave, and nearly circular.

The circumference of the articulating surface is quite projecting posteriorly, and is here marked by a deep notch that divides the extremity into two lateral *tuberosities*, which support the articular fossæ, but do not correspond to them in size, the *internal* being the larger; the *external* is more prominent behind and presents a small circular facet for the head of the fibula. The *anterior tuberosity* has been already mentioned; it is situated upon the anterior aspect of the bone about an inch below the articular surface, from whose anterior margin it is separated by a smooth triangular space perforated by several vascular foramina. The *inferior extremity* is thick, transversely elongated, and presents below a quadrilateral articular surface which is concave, but traversed from before backward by a rounded elevation, corresponding to the antero-posterior excavation upon the astragalus. The *anterior* and *posterior* margins are rounded and longer than the two lateral, and nearly parallel with each other. The *internal* margin is prolonged downward in a thick, transversely flattened, quadrangular pyramidal process, called the *internal malleolus*. The *external margin* descends but little lower than the articular surface; upon it may be seen a triangular, smooth, concave facet for articulation with the fibula, surrounded by numerous asperities for the attachment of ligaments.

The internal surface of the tibial malleolus is convex and subcutaneous, and the external, concave and smooth for articulation with the astragalus; its anterior border is rough and uneven, and the posterior, larger than the anterior, exhibits a large but shallow vertical groove for the lodgement of two of the flexor tendons of the foot; the summit is cut obliquely from behind forward and downward, and is rough, for the attachment of the internal lateral ligament of the ankle-joint.

The transverse axis of the two extremities of the tibia, owing to the torsion of the bone, are not parallel, and hence the internal malleolus is upon a plane anterior to the internal tuberosity.

The tibia articulates with the femur and astragalus, and indirectly with the patella. Its structure presents nothing peculiar.

The tibia is developed from three points, one for the shaft, and one for each of the extremities; the former makes its appearance about the thirty-fifth or fortieth day, the latter two during the first and second years.

Fig. 107.

Front view of the right fibula. 1. Styloid process. 2. Articular facet for the head of the tibia. 3. Roughness for the external lateral ligament. 4, 4, 4. Shaft of the bone. 5. External malleolus. 6. Articular surface for the astragalus. 7. Point of junction with the tibia. 8, 9, 10. Ridge for the attachment of the interosseous membrane.

The FIBULA, or as it is sometimes called the *Perone*, is as long as the tibia, upon the outer side of which it is placed, but very much smaller. The *shaft* is curved a little outward, remarkably twisted, triangular prismatic, but very irregular, and presents three narrow winding surfaces, and as many separating borders.

The *external surface* looks somewhat forward above, where it is also slightly excavated, but is turned nearly backward below, corresponding to the direction of the two peroneal muscles that are situated upon it. The *internal* inclines a little backward above, but becomes anterior below, and is divided by a longitudinal crest or ridge for the attachment of the interosseous membrane, into an anterior and posterior division, of which the posterior is broader and excavated. The *posterior*, turned slightly outward above, becomes internal below, where it terminates in a slightly convex rough surface which is in contact with the tibia. The three

borders are well marked, and follow the winding course of the surfaces; the *anterior*, which becomes external in its course downward, bifurcates at the inferior extremity, inclosing a narrow triangular surface, that may be readily felt beneath the skin; the *external* and *internal* present nothing of special interest.

The *superior extremity* or *head* is convex and rough upon its external surface, but smooth internally where it articulates with the tibia; posteriorly, it presents a small prominence, sometimes called the *styloid process*, to which the external lateral ligament of the knee-joint and the tendon of the biceps muscle are attached. The *inferior* extremity is oblong, flattened from side to side, thicker behind than before, and descends a considerable distance below the articular surface of the tibia, forming the *external malleolus* of the ankle-joint.

Its *external* surface is convex and subcutaneous; the *internal* presents a smooth, slightly concave triangular facet for contact with the astragalus, and behind this a rough depression for the attachment of the transverse ligament of the joint. The *anterior edge* is thin and uneven, the posterior thick and superficially grooved for the tendons of the peroneal muscles. The *summit* gives attachment to the external lateral ligament of the ankle-joint.

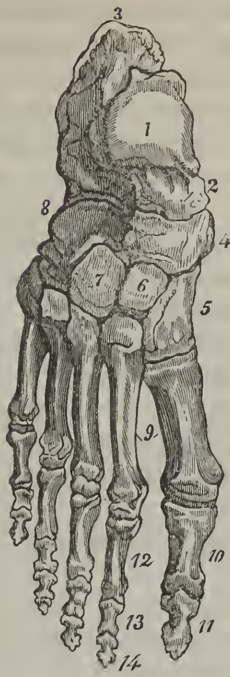
The fibula articulates with the tibia and astragalus. A longitudinal section presents a long, narrow, medullary canal with compact walls, which become gradually resolved into spongy tissue in the extremities of the bone.

Like the tibia the fibula is developed from three ossific points, of which the one for the shaft appears about the forty-fifth day.

THE FOOT.

The foot, the fourth division of the inferior extremity, consists of twenty-six separate bones joined together in such a manner as to form a firm but elastic base, which supports the weight of the body in an erect posture. It varies in size in different individuals, and in general is smaller in the female than in the male. It is elongated from before backward, flattened from above downward, broad anteriorly, thick and narrow posteriorly, convex above, and concave below. The axis of the foot, unlike that of its analogue of the upper extremity, the hand, represents the segment of a circle, whose convexity presents upward to receive the weight of the body. The

Fig. 108.



Dorsal view of the bones of the foot. 1. Trochlear surface of the astragalus for articulation with the tibia. 2. Head of the astragalus. 3. Calcaneum or heel bone. 4. Navicular or scaphoid bone. 5, 6, and 7. Internal, middle, and external cuneiform bones. 8. Cuboid bone. 9. Metatarsus. 10. First phalanx of the great toe. 11. Second phalanx of the same. 12. First phalanges of the four other toes. 13. Second phalanges. 14. Third phalanges.

extremities of the arch are formed by the heel and the extremities of the metatarsus. Like the hand, it is divided into three parts, namely, the tarsus, metatarsus, and toes.

THE TARSUS.

The tarsus forms the posterior half of the foot, and consists of seven separate bones, the astragalus, calcaneum, cuboid, scaphoid, and the three cuneiform bones.

The ASTRAGALUS is situated at the upper middle part of the tarsus, immediately below the tibia and above the calcaneum or heel-bone. It is very irregularly cuboidal, and is the second bone of the foot in size. The *superior surface* presents a large, smooth, articular eminence, convex antero-posteriorly, concave transversely, with abrupt

curved lateral margins, which are also smooth and articular for contact with the internal and external malleoli. In front of this eminence is a rough surface for the attachment of ligaments. The *inferior surface* is divided into two parts by a deep groove directed obliquely from within outward and forward, and intended for the insertion of a ligament. In front of this groove is a small flat facet, and behind it a larger one, oval in shape, and concave for articulation with the calcaneum. The *anterior surface*, which joins the scaphoid, is convex, smooth, and transversely oval; it is sometimes called the *head* of the astragalus, and behind it the bone is somewhat constricted, so as to form a kind of neck. The *posterior surface* is narrow and almost entirely occupied by an oblique groove, which lodges the tendon of the flexor muscle of the great toe. The *two lateral surfaces*, below the base of the superior articular eminence, are rough, especially the internal, which presents a depression for the attachment of the internal lateral ligament of the ankle-joint.

The astragalus articulates with the tibia and fibula, the calcaneum, and scaphoid bone.

The CALCANEUM, or *heel-bone* (*os calcis*), is situated beneath the astragalus, beyond which it projects posteriorly to form the prominence of the heel. It is the largest bone of the tarsus, and, like the preceding, is irregularly cuboidal, but considerably elongated from before backward.

The *superior surface* presents in front a rough depression for ligamentous attachment; internal to this is a flat oblong facet for articulation with the astragalus; behind the depression there is another articular facet, larger than the preceding, convex, and inclined forward and inward, thus corresponding with the facet of the astragalus, which looks in an opposite direction. Posteriorly, this surface is concave from before backward, and convex transversely.

The *inferior surface* is much narrower than the superior, and presents posteriorly an *internal* and an *external tuberosity* for the origin of the short muscles of the toes; the internal of the two is much the larger. In front of the tuberosities the bone is somewhat excavated, and in front of the excavation it is rough and tuberculated. The *anterior surface*, the smallest, is smooth, concave from above downward, and convex from side to side, and articulates with the cuboid bone. The *posterior surface*, convex, smooth above and rough below, gives attachment to Achilles's tendon. The *external surface*, larger be-

hind than before, is grooved anteriorly, and in the middle for the passage of tendons. The *internal surface*, large and concave, lodges the tendons of the flexor muscles, and the vessels and nerves which go to the plantar surface of the foot; at its superior part is a special groove for the tendon of the flexor muscle of the great toe.

The calcaneum articulates with the cuboid in front and astragalus above.

The SCAPHOID is situated at the middle of the inner margin of the tarsus. It is transversely oval or elliptical, and flattened from before backward. Its *posterior surface* is smooth and concave for articulation with the head of the astragalus; the *anterior*, also smooth and convex, is divided into three triangular facets for articulation with the three cuneiform bones. Of these three divisions the two external are broader above than below; whereas the third and largest is broader below than above. The circumference of the bone is thick, convex, and rough internally and superiorly; concave and rough below; a small external facet for contact with the cuboid may often be observed. A small tuberosity, situated below and internally, marks the insertion of the posterior tibial muscle.

The CUBOID forms the anterior and external part of the tarsus, and, as its name indicates, is cuboidal in shape. Its *superior surface*, inclined also a little outward, is flat and rough; the *inferior* is rough behind for ligamentous insertion, and presents a deep groove in front which traverses the bone obliquely from without inward and forward, and lodges the tendon of the long perineal muscle; the *anterior* is cut obliquely from without inward and forward, and is smooth for articulation with the last two metatarsal bones; the *posterior* is vertically convex and transversely concave, and corresponds to the anterior surface of the calcaneum; the *internal* presents at its middle upper part a circular facet for contact with the external cuneiform bone, and sometimes another smaller one behind this for articulation with the scaphoid; the rest of the surface is rough; the *external*, much shorter than the internal, is in fact a mere border; upon it may be observed the commencement of the groove which traverses the lower surface.

The cuboid articulates with the calcaneum, the last two metatarsal bones, the external cuneiform, and sometimes the scaphoid.

The CUNEIFORM BONES, so called from their wedge-shape, are situated in front of the scaphoid bone, and correspond to the first three metatarsal bones.

The *first* or *internal cuneiform bone* is the largest of the three, and, unlike the others, has its thick edge or base presenting downward. Of its four *surfaces*, the *anterior* is triangular, smooth, slightly concave, and articulates with the metatarsal bone of the great toe; the *posterior*, also triangular and smooth, but smaller than the preceding, joins the internal facet on the convex surface of the scaphoid; the *external* is quadrangular, smooth above where it touches the middle cuneiform, and also in front where it is in contact with the internal side of the posterior extremity of the second metatarsal, and rough below for the attachment of ligaments; the *internal* is convex and uneven. The *superior edge* is narrow, the *inferior* or *base* is broad and rough.

The *second* or *middle cuneiform bone*, the smallest of the three, has its broad edge or base presenting upward. Its *anterior surface*, smooth, triangular, and concave, is upon a plane a little posterior to that of the preceding bone, when both are in place; the *internal* and *external* surfaces are quadrangular, smooth above and behind, where they are in contact with the two other bones of the group, but rough below for the insertion of ligaments; the *posterior* is triangular and plane, and joins the middle facet on the scaphoid. The *base* or *superior border* is convex and rough; the summit edge gives attachment to ligaments.

The *external cuneiform bone* is next in point of size to the first, and like the second is placed with its base upward. Its *anterior surface* projects beyond the corresponding part of the preceding, and articulates with the third metatarsal bone; the *posterior* rests upon the third division of the convex surface of the scaphoid; the *internal* articulates with the middle cuneiform, and the external side of the posterior extremity of the second metatarsal bone; the *external* is in contact with the cuboid. The *base* is rough and concave, and the *summit* thicker than that of the two others.

THE METATARSUS.

The metatarsus, the second division of the foot, is composed of five small bony columns, placed side by side, and distinguished from each other numerically, counting from within.

Taken as a whole, the metatarsus is a quadrilateral grating, convex above and concave below. Its posterior edge is not straight, but irregular and articulated with the anterior extremity of the

tarsus, formed by the three cuneiform and scaphoid bones. The anterior edge is curved, the convexity presenting forward, and is formed by five rounded heads for articulation with the first phalanges of the toes. The internal and external edges, of which the former is the thicker, correspond to the lateral margins of the foot.

General Characters.—The metatarsal bones belong to the class of long bones, and consist, therefore, of a body and extremities. The *body* of each is triangular prismatic, and slightly curved with the convexity presenting upward, smooth, and separated from the adjoining one by an interspace for the lodgement of the interosseous muscles. The *posterior* or *tarsal extremity* is comparatively large and somewhat wedge-shaped, the broad edge or base looking upward. The tarsal surface is smooth, plane, triangular, and articulates with the tarsus; the two lateral surfaces present articular facets for union with the contiguous bones of the same group. The *anterior* or *digital extremity* is expanded into a rounded head with flattened sides, upon which may be observed a rough depression and a tubercular projection. The smooth convex surface of the head is oblong from above downward, and of greater extent below than above, corresponding thus to the flexion of the toes, which is much greater than the extension movement.

Special Characters.—The *first* metatarsal bone is the thickest and shortest of the group. Its *tarsal extremity* is elongated from above downward, and has no lateral articular facet, but presents a concave semilunar surface for articulation with the first cuneiform bone. Its *digital extremity* is large and marked below by two vertical grooves for the play of the two sesamoid bones.

The *second* is the longest of the group. Its tarsal extremity is received between the first and third cuneiform bones, resting upon the second, and articulating also with the third metatarsal bone.

The *third* and *fourth* are very nearly alike, but the former is a little the longer. When in their natural position, however, the tarsal extremity of the latter projects behind the former to reach the metatarsal surface of the cuboid, which is upon a plane posterior to that of the third cuneiform.

The *fifth* is the shortest of the group except the first. Its tarsal extremity is large, and has but one lateral articular facet. It presents upon its outer side a large triangular pyramidal process which projects obliquely backward, and a little outward for the insertion of the small peroneal muscle; being readily felt beneath the skin, it forms

an important guide to the amputation of the foot at the tarso-metatarsal articulation.

In structure and development the metatarsal bones do not differ from the metacarpal.

THE TOES.

Each of the toes, except the first, consists of three separate bones, called *phalanges*, which, in their general characters, so nearly resemble those of the fingers as not to require a separate description. The phalanges of the toes, excepting those of the great toe, are smaller than those of the fingers. Another point of difference is also found in the greater extent of the articular surfaces of the heads in the dorsal direction,* an arrangement having reference to the greater movement of extension possessed by the toes.

Development of the Bones of the Foot. The tarsus.—Ossification of the tarsal bones commences much earlier than in the corresponding parts of the hand. The latter are entirely cartilaginous at birth, but the calcaneum, astragalus, and cuboid of the former are each somewhat advanced. Each of these bones is developed from a single point, except the calcaneum, upon whose posterior extremity an epiphysis is developed about the tenth year, which joins the rest of the bone a short time after puberty. The order of appearance of the ossific points is as follows: 1, the calcaneum about the sixth month of fœtal life; 2, the astragalus about the seventh; 3, the cuboid, during the ninth; 4, the external cuneiform, in the course of the first year after birth; 5, the internal or first cuneiform in the third year; 6, the middle cuneiform in the beginning of the fourth year; and lastly, the scaphoid toward the latter part of the fourth year. The completion of the whole does not occur until the epiphysis of the calcaneum is united to the body of the bone.

The Metatarsus.—Like the metacarpal, the metatarsal bones are each developed from one principal and one epiphysary point, the latter occurring upon the tarsal extremity of the first of the series, and upon the phalangeal extremities of all the others. The central point appears in the bodies of the bones between the seventh and eighth week of fœtal life; the epiphysary point appears successively in the several bones, beginning with the first, in which the process

* This is also true of the heads of the metatarsal bones.

commences during the third year. The fifth is not entirely completed before the sixth or seventh year.

The Phalanges.—The phalanges of the toes are also developed from two ossific points, one for the shaft and anterior extremity, and one for the posterior extremity. The former makes its appearance some time after that of the corresponding metatarsal bone; the latter about the same time with the epiphysis of that bone.* Ossification of the two phalanges of the great toe, however, takes place earlier than in the others.

THE HYOID BONE.

The hyoid bone does not form a part of the skeleton proper, but is rather an appendage to the tongue and larynx between which it is situated in the upper front part of the neck. It is shaped somewhat like the Greek letter υ, from which it derives its name. It consists of a body, two large horns (cornuas), and two small ones (cornicula).

Fig. 109.

The hyoid bone seen from before. 1. The antero-superior, or convex side of the body. 2. The great horn of the left side. 3. The lesser horn of the same side. The horns were ossified to the body of the bone in the specimen from which this figure was drawn.

The *body* or central portion is flattened from before backward; it is about half an inch broad, terminates laterally in the greater horns, and has two surfaces and two bodies. The *anterior surface* is convex and marked in the middle line by a slight vertical ridge, which separates two shallow depressions for the attachment of the stylo-hyoid, sterno-hyoid, and digastric muscles. The *posterior surface* is concave, and corresponds to the epiglottis and base of the tongue. The *superior* and *inferior borders* are horizontal but irregular, and give attachment to a great number of muscles.

The *posterior* or *greater horns* (cornua), are the extremities of the bone. They are horizontal, slightly flattened above and below, and terminate in a rounded point which gives attachment to the thyrohyoid ligaments.

The *anterior* or *smaller horns* are two little conical processes, that project forward and upward from the superior border of the bone

* Quain.

where the body joins the greater horns. They generally remain cartilaginous until advanced age, and give attachment to the stylo-hyoid ligaments.

The hyoid bone is developed from five points, one for the body and one for each of the processes. Those for the body and larger horns make their appearance just before birth.

THE SESAMOID BONES.

The sesamoid bones are osseous nodules of various sizes, developed in the tendons of some of the muscles of the extremities, where their office seems to be that of a fulcrum. As a general rule they are small, rarely, except in the case of the patella, exceeding the size of a grain of coffee, which they also usually resemble in shape. They are found principally in the flexor tendons, to which law the patella is an exception also, and are nearly always present in the original tendons of the gastrocnemius muscle behind the condyles of the femur, and in the flexor tendon of the great toe beneath the head of the corresponding metatarsal bone. In structure, they resemble the short bones. They are not found in young subjects, but are developed in the substance of the tendons about the age of manhood, and often later.

ODONTOLOGY.

The teeth have been considered by various anatomists as forming a part of the skeleton, as appendages to the dermoid tissue, and as parts of the digestive apparatus, but they are now generally recognized as constituting a special structure, the study of which is called *odontology*. Although bearing some likeness to bone, they differ from this tissue in the following particulars: 1, they are destitute of periosteum; 2, they consist of an interior nervous pulp surrounded by a calcareous substance divisible into two distinct structures, called enamel and ivory, which contain no vessels or nerves; 3, they are developed from the circumference toward the centre by successive depositions; 4, they are not nourished like bone; 5, by chemical analysis they are found to contain a much larger amount of earthy matter, and the enamel is entirely destitute of gelatin; 6, their physiological relations, including their duration, are widely different; 7, their diseases are unlike. Their dissimilarities to the dermoid tissue are not so numerous, but sufficient to distinguish them.

The teeth are divided in reference to their duration into *temporary* and *permanent*. The former precede the latter in the order of their development, and subserve, as their name implies, only a temporary purpose.

The number of temporary teeth is usually twenty, ten in each jaw; the permanent set are thirty-two, sixteen in each jaw. These numbers, however, are sometimes found to vary, the varieties consisting both in excess and deficiency, but more frequently the latter.

In their natural position and relation, the permanent teeth form two parabolic curves called the dental arches, one of which is superior and the other inferior. The size of these arches, however, is not the same; the superior forms, as it were, the larger extremity of an oval, and the lower the smaller end. Each arch presents an anterior convex, and a posterior concave surface, a free border, and a base or attached border. The free borders of the two arches

are thin and sharp at the middle, but thick and uneven laterally. They do not exactly correspond at all points, owing to the smaller size of the inferior, whose anterior or middle part rests a little behind the superior, when the mouth is closed; laterally and posteriorly, however, they are directly opposed. This arrangement is connected with the different offices of the anterior and posterior divisions, the former being intended for tearing and cutting the food, and the latter for grinding it to a proper pulp-like mass.

The teeth are distinguished by their differences in size and form into three classes, namely, the incisors, the canine, and the molars. The first class numbers four in each jaw, the second two, and the third ten. They have, however, certain characters in common. Thus, each tooth consists of two distinct parts, namely, a *body*, and a *root* or *fang;* the former is free and projects beyond the gum, the latter is implanted in the alveolus or socket, and they are united with each other by a somewhat constricted part, called the *neck*, to which the gum is attached. A second general character is the nearly vertical direction of the axis of each, which is peculiar to the human race. Lastly, the bodies of all the teeth, with the exception of the canine, are of nearly equal length.

The *incisor teeth* occupy the anterior part of the dental arches, and are larger in the upper than in the lower jaw. They are distinguished into middle and lateral incisors. The middle incisors of the upper jaw are much larger than the lateral, but the inferior lateral are larger than the middle.

The bodies of the incisor teeth are wedge-shaped, and have four surfaces and a free edge. The anterior surface is convex and smooth, and somewhat broader near the edge than the root. The posterior surface, also broadest near the edge, is concave, and smooth, and often grooved in a vertical direction. The lateral surfaces, broadest near the root, are plane and less polished than the anterior. The free edge of the superior incisors is sharp and bevelled at the expense of the posterior surface, but that of the inferior is thicker and cut, as it were, from the anterior surface.

The roots of the incisor teeth are single, conoidal, flattened from side to side, and perforated at the end by a very small opening which communicates with the cavity of the tooth. The neck of each incisor is marked by an anterior and a posterior curved line, whose concavity is directed toward the free edge.

The *canine teeth*, two in each jaw, are situated between the in-

cisors and molars. They are the longest of all the teeth, and those of the upper jaw are somewhat larger than the inferior. Their bodies are broad, convex, and smooth in front, somewhat contracted and con-

Fig. 110.

Fig. 111.

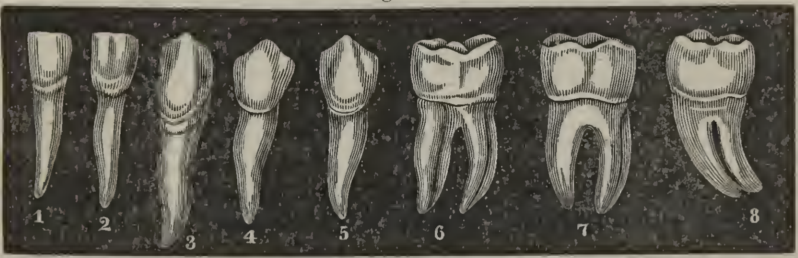


Fig. 110. Permanent teeth of the upper jaw. Fig. 111. Same of lower jaw. 1, 2. Incisors. 3. Canine. 4, 5. Bicuspids or small molars. 6, 7, 8. Large molars or grinders.

cave behind, narrow and convex on the sides, and terminated by an obtuse point which projects beyond the level of the others. Their roots are single, larger and longer than those of the incisors, conoidal in shape, grooved upon their lateral surfaces, and perforated at the summit.

The roots of the superior canines are on a line with the ascending processes of the superior maxillary bones, into the base of which they often extend. The neck, like that of the incisors, is marked by two curved lines.

The *molar teeth* are divided into two classes, the small and large; the former, two in number on each side, are situated directly behind the canine; the latter, three upon each side, occupy the posterior parts of the dental arches. They are also called *bicuspids* and *multicuspids*, which names are derived from the number of points upon their cutting edge or crown.

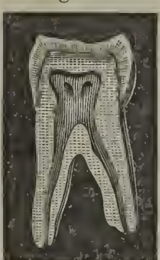
The body of the small molars (bicuspids) is irregularly cylindrical,

convex, and smooth upon its external and internal surfaces, broader, nearly plane, and less polished upon its anterior and posterior surfaces.

The free edge or crown, much more extensive than that of the incisors and canines, is elongated from within outward, and marked by two little tubercles or prominences, of which the external is the larger and more elevated. The root, generally single but sometimes bifid or double, is conoidal, flattened from before backward, and marked by a vertical groove upon its anterior and posterior surfaces. The neck is nearly circular and horizontal. The small molars have been likened to two canine teeth united.

The body of the *large molars* (multicuspids), much larger than the preceding, is cuboidal, convex upon its external and internal, and plane upon its anterior and posterior surfaces. The grinding surface of the tooth is marked by four prominences or tubercles separated by a crucial furrow. In advanced age, this surface is perfectly plane and smooth, the points having become gradually worn away. The roots or fangs of the large molars vary in number from two to five; as a general rule, however, the superior teeth have three, and the inferior two. These fangs are either divergent, or parallel for a little way and convergent at the extremities; sometimes they are hook-like; the summit of each is perforated for the dental nerves.

Fig. 112.



Vertical section of one of the large molars, showing its cavity.

The last molar tooth is called, from the lateness of its appearance, the *wisdom tooth* (dens sapientiæ). It is smaller than the others, often has but one fang, and of all the teeth is, as a general rule, most apt to decay. It is also distinguished by its having but three tubercles upon its crown.

Structure of the Teeth.—Every tooth has an internal cavity, which varies in size at different periods of life, being greatest in teeth not perfectly developed, and gradually diminishing as age advances. This cavity is hollowed out of the body of the tooth from whence it is prolonged into the fangs, upon the summits of which it terminates in an orifice for the admission of the dental bloodvessels and nerves. It follows from this that the cavity is single, in teeth which have but one root, but in those that have several roots it presents as many prolongations, all, however, uniting in the main cavity, which is situated in the body of the organ. In the fresh state, this cavity is occupied by a white, gelatinous-looking substance called the *dental pulp* or

papilla, which consists of a membranous expansion of the dental nerve together with numerous bloodvessels.

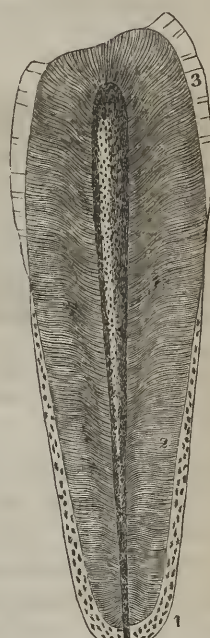
The hard part of the tooth consists of three distinct substances, namely, the dentine, the enamel, and the cement.

The *dentine* or *ivory* (Fig. 113, 2) constitutes by far the largest part of the tooth, the two other substances forming, as it were, only an external covering or crust. To the naked eye, it seems to differ but little from the compact tissue of ordinary bone ; it is, however, much harder, owing to its larger amount of earthy matter, and is entirely destitute of bloodvessels and nerves. Viewed with the microscope, it is found to be penetrated by an infinite number of minute canals or tubules (Fig. 114, 1), which commence upon the walls of the internal cavity by open mouths, and pass in an undulating and nearly parallel direction toward the external surface where they terminate. In their course these canals often bifurcate, and this is more particularly the case in those which run to the under surface of the enamel, the division taking place immediately before they reach this structure. The small size of these canals precludes the admission of the red corpuscles of the blood, but they are found to contain a transparent watery fluid, which in all probability is derived from the blood, and is supposed by physiologists to furnish nutriment to the inter-tubular substance. The chemical composition of dentine is usually stated as follows:—

Fig. 114.

1. Tubules of dentine. 2. Enamel.

Fig. 113.

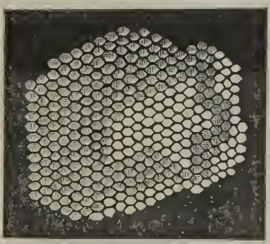


Magnified vertical section of a cuspid or canine tooth, and its several constituent parts. 1. The petrous crust. 2. Dentine. 3. Enamel. 4. The cavity of the tooth, in which the black points show the orifices of the dental tubules.

Earthy constituent	Phosphate of lime	61.95
	Phosphate of magnesia	1.25
	Carbonate of lime	5.30
	Fluoride of calcium	2.10
	Soda and chloride of sodium	1.40
Animal substance and water		28.00
		100.00

The *enamel* (Fig. 113, 3), the hardest part of the tooth, and also the hardest substance in the whole body, constitutes the external part of the body of the tooth, and forms a protecting capsule to the inclosed dentine. It is generally thickest upon the grinding surface, and becomes gradually thinner toward the neck, where it ends abruptly. Examined in mass, it is translucent, of a bluish white or milky color, and extremely brittle. The microscope shows it to consist of slightly undulating but nearly parallel columns of fibres of a hexagonal form (Figs. 114 and 115), applied by their internal extremities to the outer surface of the dentine, from which they radiate in the manner represented in Plate 112.

Fig. 115.



Transverse section of enamel, representing the hexagonal form and the arrangement of the enamel columns or fibres. (After Retzius.)

These columns are about $\frac{1}{460}$ of a line in diameter, are transversely striated, and are not tubular like those of the dentine.

No bloodvessels or nerves have ever been discovered in the enamel, and only the slightest trace of animal matter can be detected in its composition. The following is its chemical analysis:—

Phosphate of lime	85.3
Fluate of lime	3.2
Carbonate of lime	8.0
Phosphate of magnesia	1.5
Animal tissue, soda, and water	2.0
	100.0

The *cement* or *cortical substance* (crusta petrosa), (Fig. 113, 1,) is a thin lamina of osseous substance, which covers the outer surface of the roots of the teeth, and terminates at the margin of the enamel.

It does not differ essentially from the compact tissue of ordinary bone.

The teeth are implanted in the alveolar cavities or sockets, which are moulded exactly upon the roots, a delicate layer of periosteum intervening. This articulation, called *gomphosis*, would not, however, be entirely secure without the aid of the gums, which being closely attached around the neck of the tooth holds it firmly in its position.

The teeth derive their arteries from branches of the internal maxillary. Their nerves are filaments from the second and third divisions of the trifacial or fifth-pair.*

* The limits of this work preclude an account of the development of the teeth.

ARTHROLOGY.*

Arthrology has for its object the study of the connections or articulations of the several pieces of the skeleton, one with another. The manner in which these connections are made, and the means employed, vary in different parts of the body, according to the offices which the several parts have to perform. Thus, in the cranium, a close and immovable union of the bones is required for the protection of the inclosed brain; in the spinal column, solidity and a certain degree of mobility or elasticity combine to give great strength, and at the same time allow the different movements of the trunk of the body; lastly, in the extremities, solidity gives place to a great degree of mobility in accordance with the functions of the limbs.

It will be seen that there are at least three varieties of articulation, the characteristics of which are respectively: 1, immobility; 2, solidity, with a slight degree of yielding; and 3, great mobility. The first of these varieties is called synarthrosis,† the second, amphiarthrosis,‡ the third, diarthrosis.§

Synarthrosis.—All the bones of the head, except the lower jaw, are joined together by the synarthrodial or immovable articulation, but the exact manner in which the surfaces are applied is not the same between all the bones; the subdivisions that have been established by anatomists are the *indented suture*, in which the surfaces are provided with tooth-like processes; *squamous suture*, in which the edges overlap like scales; *harmonic suture*, in which there is a simple contiguity of two rough surfaces; and lastly, *schindylesis*, in which the edge of one bone is received into a groove of another.

The means of union in synarthrodial articulations consist of only

* αρθρον, a joint.

† σὺν, together, and αρθρον, articulation.

‡ αμφι, both, and αρθρον, articulation.

§ δια, through, and αρθρον, articulation.

a thin layer of the original cartilage of ossification, which, although easily demonstrated in the young subject, generally becomes ossified in advanced age.

Amphiarthrosis or *Symphysis.*—The bones united together by this mixed sort of articulation are the bodies of the vertebræ, the ilium and sacrum, and the two pubic bones. The means of union consist of a plate of fibro-cartilage, situated between the contiguous surfaces and surrounding ligaments.

Diarthrosis.—The diarthrodial or movable articulations are very numerous; they present several differences in the form of the articulating surfaces, and in the kind and extent of their motions, and have, therefore, been variously subdivided. The most important subdivisions are the following: 1. *Enarthrosis*, or the ball and socket joint, in which a rounded head is received into a corresponding cavity, as in the shoulder and hip joint. In articulations of this kind, all the different kinds of motion are allowed, namely, flexion, extension, abduction, adduction, circumduction, and rotation. 2. *Arthrosis*, in which the surfaces are plane, and the motion limited and of a gliding nature, as between the articular processes of the vertebræ; the ribs and transverse processes of the vertebræ, and the carpal and tarsal bones. 3. *Trochlear articulations* or *Ginglymus.* —This species includes all those joints in which one of the opposed surfaces is shaped like a pulley, such as the elbow joint, the knee joint, the joints of the phalanges, &c. In some of these the motions are only in opposite directions, but in others a slight degree of abduction, adduction, and circumduction are allowed.

In the diarthrodial articulations, the opposed surfaces are accurately adapted to each other, incrusted with cartilage, and invested with a synovial membrane. The means of union consist of peripheral ligaments, tendons, and muscles.

ARTICULATIONS OF THE VERTEBRAL COLUMN.

The articulations of the vertebræ with each other are of two kinds, amphiarthrodial and diarthrodial; the former occur between the bodies of the bones, and the latter between the oblique or articulating processes. In order to obtain a good view of the whole, the column should be entirely cleared of muscles and other appendages, each vertebra sawed through at its two pedicles, and the spinal cord and membranes removed.

The bodies of the vertebræ are joined together by an anterior and a posterior common ligament, and an intervertebral substance.

The *anterior common ligament* is a band of white, pearly-looking fibres, which are attached to the front of the bodies of the vertebral and intervertebral fibro-cartilages, and extend from the axis to the sacrum. It is broader below than above, and thickest in the dorsal region, and consists of several layers of fibres, the most superficial of which are stretched from one vertebra to the fourth or fifth below, but the deep seated from one to only the next below. It fills up the transverse grooves on the anterior surfaces of the bodies of the vertebræ, but upon each side of the median line the fibres are scattered and stretch across these grooves, forming canals for the passage of bloodvessels. This ligament is more adherent to the intervertebral substance and margins of the vertebræ than to the middle of their bodies.

The *posterior common ligament* is situated within the spinal canal upon the posterior aspect of the bodies of the vertebræ, and extends from the occiput to the sacrum. It is not of uniform breadth at all points, but broader opposite each plate of intervertebral substance, so that its borders have a scalloped appearance. It is closely attached to the intervertebral substance, but is separated from the middle of the bodies for the passage of veins. Its posterior surface is separated from the membranes of the spinal cord by loose cellular tissue and fat.

The *intervertebral substance* consists of a series of plates or disks of fibro-cartilage, situated between the articular surfaces of the bodies of all the vertebræ, excepting the first two. These disks correspond exactly to the surfaces between which they are placed, and are, therefore, for the most part slightly convex upon both sides, transversely oval in the lumbar and cervical regions, and circular in the dorsal. Their thickness varies with the degree of motion in the part, and is greater, therefore, in the cervical and lumbar regions than in the dorsal. Again, they are not uniformly thick, but assist in forming the curvatures of the spine even more than the bodies of the vertebræ themselves, and are, therefore, thicker anteriorly than posteriorly in the lumbar and cervical regions, and the reverse in the dorsal. Taken together, they form at least one-fourth of the length of the spinal column from the skull to the sacrum.

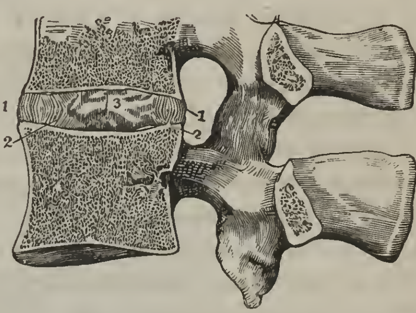
Structure.—By a vertical division, the intervertebral substance will be seen to consist of a series of concentric plates, which are placed upon edge between the opposed bones, and inclose at the

centre a soft pulpy substance of a whitish, glairy, jelly-like appearance. The cut edges of the plates, as seen in a section of this kind, are not perfectly straight, but somewhat curved, the most external presenting a convexity outward, and the internal inward (see Fig. 117). Interposed between these concentric plates, is a small quantity

Fig. 116.

A lumbar vertebra, with a horizontal section of intervertebral substance above it. At the circumference, the concentric arrangement of the layers of the latter is shown, and in the middle the pulpy substance is indicated.

Fig. 117.



A vertical section of two vertebræ, and the substance interposed between their bodies. The direction of the layers of the intervertebral substance is displayed. 1. Layers curved outwards. 2. Those curved inwards. 3. Pulpy substance in the middle.

of the same glairy substance found at the centre, which gradually increases from without inward. The concentric plates are composed of fibres which pass obliquely between the two bones, those of one plate crossing the direction of the fibres of the adjacent plate. In a horizontal section of the intervertebral substance, these concentric plates look like concentric fibres, and were so considered by the older anatomists. The inclosed semifluid pulp is entirely devoid of fibres, very elastic, and seems to be in a state of constant compression, so that when a knife is plunged through the concentric plates and withdrawn, the pulp often follows it and forms a kind of hernia externally.

The articulating processes of the vertebræ form true diarthrodial joints, and are therefore covered with cartilage and invested with synovial membrane. They are bound together by numerous short peripheral fibres, which forms an imperfect kind of capsule, somewhat longer and looser in the cervical and lumbar regions than in the dorsal, corresponding to the greater mobility of the former.

Besides the ligaments immediately surrounding the two sets of articulations between the vertebræ, others connect the arches or laminæ, and the transverse and spinous processes.

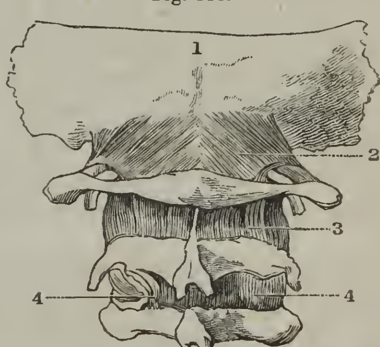
The ligaments (*ligamenta subflava*), connecting the laminæ or arches, are very short and broad, extending on each side from the root of the transverse to the root of the spinous process. They consist of yellow elastic tissue, whose fibres are attached above to the anterior aspect of the lower margin of the arch, and below to the posterior aspect of the superior margin.

The *inter-transverse ligaments* are so blended with the tendons of the surrounding muscles of the back, that it is difficult, and oftentimes impossible, to demonstrate them as separate structures. They consist of very short white fibres, passing directly between the corresponding borders of the processes.

Two sets of ligaments are recognized as connecting the spinous processes, the *supra-spinous* and the *inter-spinous ligaments.* The former are quite distinct, and consist of small fascicles of fibres attached to the summit of each spinous process, and extending to the third or fourth bone below, thus forming a continuous cord from the seventh cervical vertebra to the sacrum. The inter-spinous ligaments are found only in the dorsal and lumbar regions; they consist of a few short narrow bundles of fibres, placed nearly vertically between the corresponding borders of the spinous processes, and extending from the root to near the point of each.

Articulations of the First and Second Vertebræ.—This articulation, called the *atlanto-axoid*, is a quadruple diarthrosis, and results

Fig. 118.

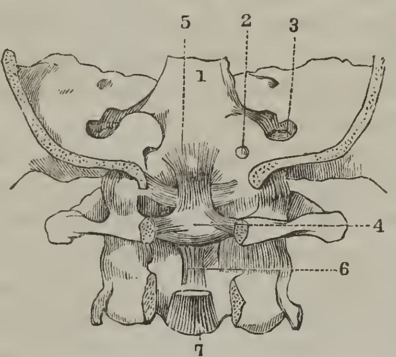


1. Occiput. 2. Posterior occipito-atlantal ligament. 3. Posterior atlanto-axoid ligament. 4, 4. Second pair of yellow ligaments.

from the contact of the articulating processes of the two bones, and of the odontoid process of the axis with the anterior arch of the atlas and the transverse ligament.

The articulation of the articulating processes does not differ from that between the corresponding parts of the other vertebræ, except in the shape and direction of the surfaces, which, as before mentioned, are circular and nearly horizontal. These surfaces are covered with cartilage, provided with synovial membranes, and bound together by surrounding ligamentous fibres, which form an imperfect capsule upon each side.

Fig. 119.



In this drawing, the posterior arch of the occiput and two upper vertebræ are removed. 1. Basilar process. 2. Anterior condyloid foramen. 3. Jugular foramen. 4. Transverse ligament of the atlas. 5. Its superior fasciculus. 6. Its inferior fasciculus. 7. Posterior vertebral ligament.

The articulation between the odontoid process and the atlas, consists of a small, oblong, concave facet upon the posterior surface of the anterior arch, and a corresponding smooth convex surface upon the anterior aspect of the process; the two are covered with cartilage and provided with a loose synovial membrane.

The ligaments which bind the two borders together are three in number: 1. The *anterior atlanto-axoid ligament*, which is tolerably thick, broad, and strong, and extends from the lower edge of the anterior arch of the atlas to the base of the odontoid process, where it is continuous with the anterior common ligament of the spinal column. 2. The *posterior atlanto-axoid ligament* is thin and membranous, and is interposed between the posterior arch of the atlas and the laminæ of the axis. 3. The *transverse ligament* is stretched between the roots of the superior articulating processes of the atlas, and forms with the anterior arch of this bone a kind of ring for the reception of the odontoid process. It is thick and strong, flattened from before backward, and presents upon its anterior surface a small concave

cartilaginous facet, for contact with the posterior surface of the odontoid process, which is similarly furnished, a synovial membrane intervening. A small fibrous band passes from the middle of this ligament, to the posterior edge of the basilar process of the occipital bone above, and to the body of the axis below, where it is continuous with the posterior common ligament.

Articulations of the First and Second Vertebræ with the Occipital Bone.—The atlas is articulated with the occipital bone, by the contact of the articulating processes of the former with the condyloid processes of the latter, forming thus a double diarthrosis. The contiguous surfaces of these parts are covered with cartilage, furnished with synovial membrane, and surrounded by short ligamentous fibres, which form a sort of capsule for each joint.

The ligaments are four in number: 1. The *anterior atlanto-occipital ligament*, extends between the posterior margin of the basilar process of the occipital bone and the anterior arch of the atlas. In the median line, the fibres are collected into a thick rounded cord, which is attached below to the tubercle of the anterior arch; upon each side of this the ligament is membraniform, but still quite thick and strong. 2. The *posterior atlanto-occipital ligament* is very thin and delicate, and hardly deserves to be mentioned. It extends from the posterior edge of the great foramen of the occipital bone to the superior margin of the posterior arch of the atlas. 3. The two *lateral atlanto-occipital ligaments*, one upon each side, are short, strong, and cord-like; they are attached above to the jugular process of the occipital bone, and below to the base of the transverse process of the atlas.

The occipital bone, although not in contact with the second vertebra, is attached to it by several strong ligaments.

The *occipito-axoid ligament* is a continuation of the posterior common ligament of the spinal column, from the posterior surface of the body of the axis to the anterior margin of the great foramen. It is broad, covers in the odontoid process behind, and is sometimes considered as consisting of three portions, a middle, and two lateral.

The *odontoid ligaments* are three in number, two lateral, and one median. The *lateral*, *moderator*, or *check ligaments*, as they are variously termed, extend between the sides of the extremity of the odontoid process, and two rough depressions upon the inner side of the condyles of the occiput. They are thick and strong, and, by their almost horizontal direction, serve to check the rotatory motions of

the head. The *middle odontoid ligament* consists of a few scattered fibres extending from the summit of the odontoid process to the anterior margin of the great foramen.

ARTICULATIONS OF THE CRANIUM.

All the bones of the cranium are joined together by synarthrodial articulations, which form what are commonly known as the sutures of the skull. This mode of union is particularly adapted to the cranium, as it is more necessary here, than in any other part of the skeleton, to have perfect solidity without the least degree of motion.

The exact manner in which the edge of the bones are arranged is not the same in all parts of the cranium. Thus, in the vaulted portion, the opposed edges are nearly all serrated or denticulated, the slightest film of cartilage intervening; but at the base these indentations are much less marked, the solidity here depending, in a great measure, upon the greater breadth of the opposed surfaces, and their firm attachment to each other by strong ligamentous and fibro-cartilage.

For a description of the conformation and disposition of these articular surfaces and margins, the student is referred to the account of the separate bones, and to that of the skull in general.

ARTICULATIONS OF THE FACE.

The union of the bones of the face with one another is also synarthrodial, and here we have all the varieties which this species of articulation presents. Thus, in the union of the nasal and superior maxillary bones with the frontal, there exists a true *denticulated suture;* in that between the orbital plate of the ethmoid and the sphenoid, and between the palate bone and the pterygoid processes, simple juxtaposition or *harmonica;* in that between the vomer and the median ridge, on the floor of the nasal cavities, *schindylesis;* in that between the vomer and sphenoid, *articulation by mutual reception.*

The means of union between these bones consist simply of a thin layer of the cartilage of ossification. The configuration of the surfaces makes any extrinsic ligaments unnecessary.

Temporo-Maxillary Articulation.—The articulation between the lower jaw and temporal bones is a double diarthrosis. The articulating surfaces are the two condyles of the former bone, and the two glenoid cavities of the latter. The glenoid cavity, as already described, is transversely oval, and divided by the glenoid fissure into two parts, of which only the anterior is articular. The transverse root of the zygoma, which is convex from before backward and concave from within outward, bounds the cavity in front, and also enters into the articulation. The condyles are transversely oval with their long axes directed slightly backward, and are found in man, and in the ruminantia, always disproportionately small when compared with the glenoid cavities.

As in all other diarthrodial articulations, the opposed surfaces are incrusted with cartilage, and invested with synovial membrane, but they are here separated by an intervening plate of fibro-cartilage (*inter-articular fibro-cartilage*). This plate or disk is transversely oval, thick at its circumference, but thin and often perforated at its middle. Its two surfaces are smooth and free, and accommodate themselves to the shape of the surfaces with which they are in contact. The fibres of which it is composed are very close and disposed in a concentric manner.

When the inter-articular fibro-cartilage is not perforated, there are two separate synovial membranes in the joint, one above and the other below, of which the inferior is not so loose as the superior, so that the plate is more closely applied to the condyle than to the glenoid cavity.

The special extrinsic means of union consist really of but one ligament, namely, the external lateral, but anatomists generally describe an internal lateral and a stylo-maxillary ligament as also forming a part of the articulation.

The *external lateral ligament* is a thick band extending from the tubercle, at the junction of the two roots of the zygoma, backward and downward to the outside of the neck of the condyle. Its external surface is attached to the skin, and its internal to the inter-articular fibro-cartilage and the two synovial capsules.

The *internal lateral ligament* is a thin band of dense fascia, extending from the spinous process of the sphenoid bone to the little process, which forms the internal edge of the superior orifice of the dental canal. Its main use seems to be to protect the dental vessels and nerves, which are situated between it and the neck of the lower jaw.

The *stylo-maxillary ligament* is a fold of the deep cervical fascia, connected above to the styloid process, and below to the angle of the jaw.

In addition to the external lateral ligament, short ligamentous fibres surround the synovial membranes, and assist in keeping the bones in contact, and the inter-articular fibro-cartilage in its place.

ARTICULATIONS OF THE THORAX.

These consist of the union of the ribs with the bodies and transverse processes of the dorsal vertebræ, and in front, with the costal cartilages, and through them with the sternum; also of the junction of the cartilages of the false ribs with each other.

Costo-Vertebral Articulations.—These are double diarthrodial articulations. Each rib is joined by its head to the pit upon the sides of the bodies of the vertebræ, and by its tubercle, to the summit of the transverse process of the vertebræ below.

The former of these articulations, that between the head of the rib and the bodies of the vertebræ, is maintained: 1, by an *anterior* or *stellate ligament*, whose fibres are collected into three bundles that diverge from the head of the rib and are inserted, one into the body of the upper of the two vertebræ upon which the articular facet is situated, one to the vertebra below, and the third or middle one to the intervertebral substance; 2, by an *inter-articular ligament*, which consists of a short thin bundle of fibres, extending between the projecting ridge upon the head of the rib to the intervertebral substance at the bottom of the pit. This ligament divides the articulation into two parts, each of which is provided with a separate synovial membrane.

The union between the rib and the transverse process called the *costo-transverse articulation*, is maintained by three ligaments, also named costo-transverse, and distinguished by their position into an anterior, middle, and posterior.

The *anterior* (superior by Cruveilhier) *costo-transverse ligament* extends obliquely from the inferior edge of each transverse process to the superior edge of the neck of the rib below. It seems often to consist of two or more bundles, and is properly only a continuation of the aponeurosis which covers the external intercostal muscle, and separates the anterior and posterior branches of the intercostal vessels and nerves.

The *middle* or *interosseous costo-transverse ligament* consists of a number of short but very strong bundles of fibres, stretched between the anterior surface of the transverse process, and the posterior surface of the neck of the rib. The strength of the costo-vertebral articulations is mainly due to this ligament, which forms a sort of amphiarthrodial articulation between the surfaces which it connects.

The *posterior costo-transverse ligament* is a short thick band of fibres, extending from the summit of the transverse process to the outer margin of the tubercle of the corresponding rib.

The heads of the first, eleventh, and twelfth ribs being received into cavities formed respectively upon only one vertebra, the inter-articular ligament is here wanting, and in the case of the last two, there is also no costo-transverse articulation, but a middle costo-transverse ligament.

Costo-Sternal Articulations.—The true ribs are joined to the lateral margins of the sternum, through the intervention of their costal cartilages, the anterior extremities of which are received into corresponding pits, a true diarthrodial synovial membrane intervening. The means of union consist of an anterior and a posterior ligament.

The *anterior costo* or *chondro-sternal ligament* is composed of thin scattered fibres, which radiate from the anterior edge of the extremity of each cartilage, and become blended with the fibrous covering of the corresponding surface of the sternum, and with the sternal attachment of the great pectoral muscle. The *posterior ligament* is like the anterior, but its fibres are less numerous.

The presence of a synovial membrane can be almost always readily demonstrated in all of the articulations, except the first; here the cartilage is often continuous with the sternum without any such provision.

Besides the ligaments already mentioned, the sixth and seventh cartilages possess a thin triangular layer of fibres, which connects them to the ensiform or xyphoid cartilage, and is hence called the *costo-xyphoid ligament.*

Articulation of the Costal Cartilages with each other.—The costal cartilages, from the sixth to the ninth inclusive, are joined together by an anterior and a posterior vertical bundle of fibres, of which the former is much the thicker and stronger. Between the contiguous surfaces are distinct synovial membranes.

ARTICULATIONS OF THE SUPERIOR OR THORACIC EXTREMITIES.

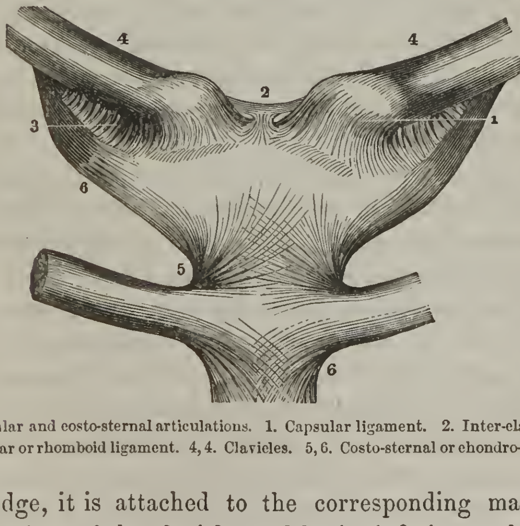
The bones of the shoulder, the first division of the upper extremity, form but one articulation with the trunk, namely, the sterno-clavicular; one with each other, the acromio-clavicular; and one with the arm bone, the scapulo-humeral or shoulder-joint.

The remaining articulations of this extremity are the elbow-joint, the wrist-joint, including the junction of the bones of the wrist with each other, with the bones of the forearm, and with the metacarpal bones; lastly, the several joints of the fingers and thumb.

The STERNO-CLAVICULAR ARTICULATION is diarthrodial, and belongs to that variety in which there is a reception of the opposed bones. It is remarkable, also, for the crucial disposition of the long diameters of the two opposed surfaces, the end of the clavicle presenting its long diameter from before backward, and the notch of the sternum from within outward. Like the temporo-maxillary, this articulation is divided into two parts by an inter-articular plate of fibro-cartilage, each division being provided with a separate synovial membrane.

The plate of *inter-articular fibro-cartilage* is thick toward the edges, but thin and sometimes perforated at the centre. By its superior

Fig. 120.



Sterno-clavicular and costo-sternal articulations. 1. Capsular ligament. 2. Inter-clavicular ligament. 3. Costo-clavicular or rhomboid ligament. 4, 4. Clavicles. 5, 6. Costo-sternal or chondro-sternal ligaments.

posterior edge, it is attached to the corresponding margin of the articular surface of the clavicle, and by its inferior to the margin of

the surface of the sternum, near the insertion of the cartilage of the first rib.

The means of union consist of a capsular, an inter-clavicular, and a costo-clavicular ligament.

The *capsular ligament* is a fibrous bag or capsule which surrounds the whole joint. Its fibres extend from the circumference of the end of the clavicle to the margins of the articular notch of the sternum. This fibrous capsule is thinner and looser in front than behind, "which may partly account for the more frequent dislocations of this end of the clavicle forward."*

The *inter-clavicular ligament* is a tolerably thick fibrous band, extending between the superior posterior margins of the inner ends of the clavicles, and attached by its middle to the back part of the middle notch or *fourchette* of the sternum.

The *costo-clavicular ligament*, although not in immediate connection with the joint, assists in binding the bones together. It is short but of considerable thickness and strength, and extends from the cartilage of the first rib obliquely upward and outward, to the inner side of the rough tubercle upon the under surface of the clavicle. The outer side of this tubercle is smooth, and often furnished with cartilage and synovial membrane for articulation with the upper surface of the first rib.

The ACROMIO-CLAVICULAR ARTICULATION (Fig. 121) is formed between the outer extremity of the clavicle and the inner margin of the acromion process. The articular surfaces are elliptical, and vary in size in different individuals, according to the amount and nature of exercise to which the corresponding arm has been accustomed. Between the surfaces is sometimes found a small inter-articular fibro-cartilage.

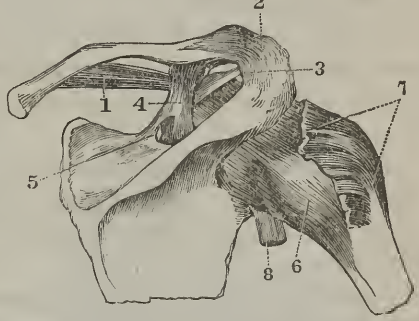
The *means of union* consist of a fibrous capsule, which is thick and strong above, but thin and membranous below. Besides this, however, the bones are bound together by a strong ligament extending from the under and posterior surface of the clavicle to the coracoid process, and hence called the *coraco-clavicular ligament*. It is divided into two parts or bundles, distinguished from each other by the names *conoid* and *trapezoid*, terms expressive of their respective shape. The former, the conoid, is posterior, nearly vertical, and attached by its lower extremity to the base of the coracoid process. The trapezoid is oblique in its direction, attached by one

* Cruveilhier.

extremity to the inner edge and base of the coracoid process, and by the other, to the ridge on the lower surface of the clavicle near its outer end.

The SCAPULO-HUMERAL, or SHOULDER JOINT.—Of all the articulations in the body, this probably is the most interesting on account of the great latitude of motion which it allows the arm, and the frequent accidents to which it is subject. The opposed surfaces, the small, shallow glenoid cavity of the scapula, and the large hemispherical head of the humerus, seem greatly out of proportion, and offer no mechanical conformation whatever for the security of the joint, but are held together entirely by the capsular ligament and the surrounding muscles, the tendons of some of which, in fact, form a part of the ligament. The joint is also protected above by the acromion and coracoid processes, and by the coraco-acromial ligament. Another structure, forming an integral part of the articulation, is the *glenoid ligament*, which consists of a bundle of tendinous fibres surrounding, and closely attached to the circumference of the glenoid surface, thus increasing its extent and deepening its concavity; this ligament is continuous superiorly with the tendon of the long head of the biceps muscle, which here bifurcates, and cannot be distinguished from the ligament itself.

Fig. 121.



Scapulo-humeral articulation. 2. Acromio-clavicular ligament. 3. Coraco-acromial ligament. 4. Coraco-clavicular ligament. 5. Coracoid or supra-scapular ligament. 6. Capsular ligament. 7. Tendons of the supra-spinate, infra-spinate, and small teres muscles. 8. Tendon of the long head of the biceps.

The *capsular ligament* is attached by one extremity to the circumference of the glenoid cavity just behind the glenoid ligament, and by the other, to the circular groove (anatomical neck) which limits the articular head of the humerus. It is loose and thin below, but thick and strong throughout the rest of its extent, where it is blended with the tendons of the subscapular, supra-spinate, infra-spinate, and small teres muscles. It is also strengthened above and in front, by a bundle of fibres called the *coraco-humeral ligament*, which originates from the coracoid process, and spreads out upon the surface of the capsular ligament. If the tendons of the surrounding

muscles are divided, the laxity of the capsular ligament allows the humerus to fall away from the glenoid surface to the distance of nearly half an inch.

The *synovial membrane* lines the internal surface of the capsular ligament, and where this is deficient, the tendons of some of the muscles already mentioned, particularly the subscapular; upon the surface of the latter, it is prolonged a short distance along the inner side of the root of the coracoid process, thus forming a gliding surface for the tendon.* Superiorly, it is thrown into a tubular sheath around the tendon of the long head of the biceps muscle, which passes through this part of the joint to become attached to the superior part of the glenoid ligament.

Between the capsular ligament, and the arch formed by the acromion and coracoid processes and the coraco-acromial ligament, is a considerable sized bursa, which, however, has no communication with the joint.

The *articular cartilage*, incrusting the head of the humerus, is thick near the circumference, but quite thin at the centre of the convexity; that upon the glenoid surface is reversed, being thickest at the centre.

The movements of which this joint is susceptible are adduction, abduction, elevation, depression, rotation, and circumduction, all of which are more perfectly performed than in any other joint in the body.

THE ELBOW JOINT.

The surfaces entering into this articulation are the lower end of the humerus, the greater sigmoid notch of the ulna, and the cup-shaped excavation upon the head of the radius. The opposition between the humerus and ulna (humero-ulnar articulation) is a true ginglymus, and that between the humerus and radius (humero-radial articulation) belongs to the ball and socket variety; both, however, constitute but one joint. The ligaments binding the bones together are four in number, two lateral, an anterior, and a posterior, which are all continuous with each other at their edges, and thus form an imperfect capsule.

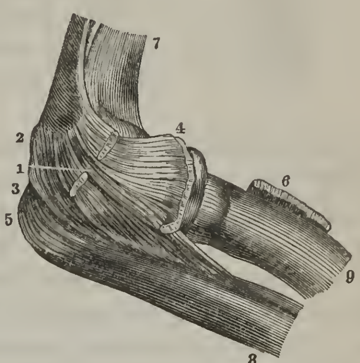
The *internal lateral ligament* consists of two triangular bundles

* In place of this prolongation a bursa is sometimes found to occupy this situation.

of fibres, one placed anteriorly and the other posteriorly, the former extending from the internal tuberosity in front, to the whole length of the internal side of the coronoid process of the ulna, and the latter, from the posterior part of the condyle to the whole extent of the internal margin of the olecranon. The *external lateral ligament*, also triangular, is attached above to the corresponding condyle of the humerus, and below is blended with the annular ligament that surrounds the head of the radius. Both of these lateral ligaments are intimately connected with the origins of the flexor and extensor muscles of the forearm.

The *anterior ligament* is thin and membranous, and consists of fibres which cross each other obliquely and at right angles; it extends from the upper margin of the coronoid cavity to the lower part of the coronoid process, and is connected externally with the annular ligament of the radius. The *posterior ligament* consists of a few scattered fibres stretched between the upper and lateral margins of the olecranoid cavity to the apex and sides of the olecranoid process; it hardly deserves the name of a ligament. These two ligaments seem only to complete the capsule in front and behind, and to support the synovial membrane; the strength of the joint in these situations depends entirely upon the anterior brachial and the triceps muscles.

Fig. 122.



The elbow-joint. 1. External lateral ligament, blended with the extensor tendons. 2, 3, 4, 5. Capsular ligament. 6. Tendon of the biceps. 7. Humerus. 8. Ulna. 9. Radius.

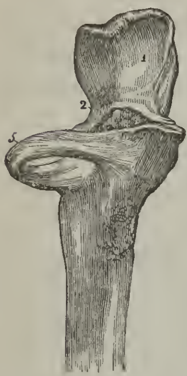
The *synovial membrane* lines the internal surface of the capsule formed by the four ligaments, and the coronoid and olecranoid cavities. It covers the articular surfaces of the three bones, and is prolonged into the articulation between the head of the radius and the smaller sigmoid notch of the ulna, lining this cavity and the internal surface of the annular ligament, and investing the circumference of the head of the radius.

Superior Radio-Ulnar Articulation is formed between the circumference of the button-like head of the radius and the smaller

sigmoid notch of the ulna, these two surfaces being covered with cartilage, and invested by a prolongation of the synovial membrane of the preceding joint.

The means of union consist of a single fibrous band, called the *annular* or *orbicular ligament*, which extends around the head of the radius, from one extremity of the notch to the other. This ligament, although thick and strong, is of a membranous form, lined internally by the synovial membrane, and continuous externally with the external lateral ligament of the elbow-joint. Its lower margin is connected to the neck of the radius, and is contracted so as to keep the head of the bone in its place.

Fig. 123.



1. Articular surface of olecranon process of the ulna. 2. Coronoid process. 3. Orbicular ligament surrounding the neck of the radius.

The *synovial membrane*, as before mentioned, is a continuation of that of the elbow-joint.

Inferior Radio-Ulnar Articulation.—The inferior extremities of the radius and ulna are joined together very much in the same manner as the superior; but here (in the inferior articulation) the position of the surfaces is reversed, the cavity is upon the inner side of the extremity of the radius and receives the outer border of the head of the ulna. There is, however, no true annular ligament, but in its place an anterior and a posterior set of ligamentous fibres, extending from the extremities of the sigmoid notch to the anterior and posterior surfaces of the extremity of the ulna, where they are attached, and also short and strong interosseous fibres immediately above the articulation.

Besides these transverse ligaments, there is another and a very different structure uniting the two bones. This is the *triangular cartilage*, which, as its name indicates, is a triangular-shaped plate of cartilage, or rather fibro-cartilage, situated below the head of the ulna, and extending from the base of the styloid process, where it is attached by one angle, to the lower margin of the sigmoid notch, and continuous with the articular cartilage on the lower extremity of the radius. It is tolerably thick near the styloid process, but becomes thin towards its radial border. Besides assisting in binding the two bones together, it performs the office of an inter-articular cartilage in breaking the force of shocks, &c., and, " above all, it restores the

level of the inferior radio-ulnar surface, by filling out the deficiency formed by the projection of the radius below the ulna."

The *synovial membrane* is situated between the triangular cartilage and the head of the ulna, and is prolonged upward between the opposed surfaces of the articulation. It has no connection or communication with the synovial membrane of the radio-carpal joint.

Interosseous Membrane.—The space between the radius and ulna is occupied by an aponeurotic membrane, which seems not only to bind the bones together but to give origin to muscles. It is broadest in the middle, and is deficient above and below for the passage of bloodvessels and nerves. Its fibres run for the most part obliquely downward and upward from the radius to the ulna, but superiorly, there is a single band, improperly called the *round ligament*, which is stretched from the outer side of the coronoid process of the ulna to the lower part of the tuberosity of the radius.

Radio-Carpal or Wrist Joint.—The parts between this articulation consist of a transversely oval, concave surface, formed by the lower extremity of the radius and the triangular fibro-cartilage, and of a transversely elongated head or condyle, formed by the first three bones of the superior row of the carpus. The parts are united by four ligaments, two lateral, an anterior, and a posterior; these, however, are all continuous with each other at the margins, thus forming a true capsule.

The *internal lateral ligament* is a tolerably thick rounded cord, which extends from the outer side of the styloid process of the ulna to the posterior surface of the cuneiform bone, with some of its fibres diverging to the pisiform. The deep surface of this ligament is lined by the synovial membrane of the joint. The *external lateral ligament*, thinner but broader than the preceding, is attached above to the styloid process of the radius, and below to the outer side of the scaphoid bone.

The *anterior ligament* is thin and membranous, and is divided into several separate bands by openings occupied by bloodvessels, and by adipose and areolar tissue. It is attached above to the anterior margin of the lower extremity of the radius, and below to the first row of carpal bones, the fibres being directed obliquely from above downward and inward. A separate ligament is sometimes described as originating by a small extremity from the neighborhood of the base

of the styloid process of the ulna, and passing obliquely downward and outward to be inserted broadly into the scaphoid bone. The *posterior ligament* is thinner and narrower than the anterior. It stretches from the posterior border of the lower extremity of the radius, to the corresponding surfaces of the cuneiform and semilunar bones. This ligament cannot be separated from the sheaths of the tendons which pass along the posterior surface of the carpus.

Besides these four ligaments, the tendons of the flexor and extensor muscles perform a very essential part in giving strength to the articulation.

The *synovial membrane* is very simple in its distribution. It covers the two opposed surfaces, and from these is continued upon the corresponding surfaces of the ligaments, which thus serve for its support.

Articulations of the Carpal Bones with one another.—These consist of the articulations of the bones of each row, and of one row with the other.

The first three bones of the first row are bound together by interosseous fibro-cartilage, and by palmar and dorsal ligaments.

The *interosseous fibro-cartilage* is situated upon each lateral surface of the semilunar bone, so as to connect this bone with the scaphoid upon one side, and the cuneiform upon the other. It consists of small fibrous bundles of a reddish color, and long enough to permit some degree of gliding between the opposed surfaces.

The *palmar* and *dorsal ligaments* are bands of fibres, extending transversely from the cuneiform bone to the one on each side, upon the anterior and posterior aspects of the carpus.

The pisiform bone is placed in front of the cuneiform, to which it is articulated by a single facet, a small isolated synovial sac intervening. Its means of attachment are numerous small interosseous fascicles of fibres, and two distinct ligaments, one of which extends to the process of the unciform, and the other to the base of the fifth metacarpal bone.

The four bones of the second row are joined together like the three of the first, but their union is much more compact, on account of the greater density and shortness of the interosseous fibres.

The palmar and dorsal ligaments are three in number, of which, as is the case in the first row, the former are thicker and stronger.

The articulation of the two rows is a kind of mutual dovetailing,

the head of the magnum being received into a concavity formed by the scaphoid and semilunar, and the lower extremity of the scaphoid into a smaller excavation formed by the trapezium, trapezoid, and magnum. They are united by four sets of ligaments, one anterior, one posterior, and two lateral. The *lateral ligaments* are situated, respectively, upon the radial and ulnar borders of the carpus, the external stretching from the scaphoid to the trapezium, and the internal from the cuneiform to the unciform. The *anterior* or *palmar ligament*, thick and strong, consists of radiating fibres extending from the first three bones of the first row to the magnum. The *posterior* or *dorsal ligament* is not well defined, being composed of scattered fibres running from one row to the other.

The *Synovial Membrane.*—The articulations of the carpal bones are each furnished with a prolongation of one common synovial sac. This is placed between the two rows, and sends its little sacculated processes between the several bones, two for the first and three for the second row. The latter communicate with the synovial sac of the carpo-metacarpal articulation, and the former also sometimes with the sac of the radio-carpal. As before mentioned, the sac between the pisiform and cuneiform bones is entirely isolated.

THE CARPO-METACARPAL ARTICULATIONS.

The articulation between the trapezium and the first metacarpal bone, belongs to that class of joints in which there is a mutual reception of the opposed surfaces.

The means of union, besides the surrounding tendons, which give very material aid, consist of a well-formed capsular ligament and a separate synovial membrane, both of which are sufficiently loose to permit all the motions except rotation.

The articulation between the remaining four metacarpal bones and the corresponding parts of the carpus is also diarthrodial, but so close as to allow only the slightest degree of motion.

The line of contact between the opposed surfaces is made irregular by the second metacarpal bone being received into a mortise-like notch formed by the trapezium, trapezoid, and magnum.

The ligaments are *intrinsic* and *extrinsic*. The former are placed upon the dorsal and palmar aspects of the hand, and consist of numerous fascicles, of which some are oblique and others vertical;

the latter are short, thick, interosseous fibres, running between the nearest parts of the opposed surfaces.

The synovial membrane, continuous with that between the two rows of the carpal bones, follows the irregular line of the articulation, and is prolonged between the contiguous sides of the corresponding extremities of the metacarpal bones.

METACARPAL ARTICULATIONS.

The metacarpal bones are articulated with each other, both at their superior and inferior extremities. *Superiorly*, the articular surfaces are small, irregular facets, covered with cartilage and provided with prolongations of the carpo-metacarpal synovial membrane. They are united by three transverse fibrous bands upon the palmar and dorsal surfaces, and numerous short interosseous fascicles, passing directly between the contiguous parts around the articular facets. The lower or digital extremities of the bones are simply bound together, without a true articulation.

The ligaments are thin fibrous bands placed upon the palmar aspect, and numerous interosseous bundles. The former constitutes what is called the *transverse ligament.*

THE METACARPO-PHALANGEAL ARTICULATIONS.

These articulations are five in number, and are all exactly alike.

Articular Surfaces.—The head of each metacarpal bone is flattened from side to side, and its articular surface elongated from before backward, and prolonged much farther upon the palmar than upon the dorsal aspect of the bone. The metacarpal extremity of the first phalanx presents a shallow, transversely-oblong depression, slightly deepened in the recent state, by the incrusting cartilage, which is thicker at the circumference than at the centre.

The ligaments are three in number, two lateral and an anterior. *The lateral ligaments* are very strong, flat, and glistening, and radiate obliquely forward from the tubercle and depression on each side of the head of the metacarpal bone, to corresponding tubercles upon the sides of the superior extremity of the first phalanx. *The anterior ligament* is dense and thick, and occupies the space between the two lateral in front. It is closely attached to the first phalanx,

rather loosely to the metacarpal bone, and is grooved upon its palmar aspect for the flexor tendons of the fingers.

The synovial membrane covers the articular surfaces of the bones and the corresponding faces of the ligaments.

THE PHALANGEAL ARTICULATIONS.

These belong to the angular ginglymus class, and are nine in number, namely, two for each finger and one for the thumb. The inferior articular surface of each phalanx is flattened from before backward, and presents two small tubercles or condyles, separated by a slight antero-posterior groove, and the superior extremity, two corresponding depressions with an intervening ridge.

The ligaments are three in number, two lateral and an anterior, and do not differ materially from those of the metacarpo-phalangeal articulation.

ARTICULATIONS OF THE INFERIOR EXTREMITIES.

Pelvic Articulations.—The innominate or hip bones form the lateral and anterior walls of the pelvis, and are articulated to the sacrum, to each other, and to the femurs.

The Sacro-Iliac Articulation or Symphysis.—This belongs to the amphi-arthrodial class of articulations, but the motion is very slight, and many anatomists deny its existence altogether.

The opposed surfaces are auricular, very uneven, and incrusted with a thin layer of dense fibro-cartilage, which is thicker upon the sacrum than upon the ilium. From the corresponding surfaces of the cartilage, when the joint is laid open, there may be scraped a small quantity of soft, yellowish gelatinous substance, which bears a very close resemblance to the semifluid matter in the centre of the intervertebral disks.* The ligaments are the sacro-iliac, and the sacro-ischiatic.

* Some modern anatomists affirm that a synovial membrane is developed in the articulation during pregnancy, a statement, in my opinion, wholly unworthy its high authority. Aside from the fact that no one can positively assert that a greater degree of motion between the two bones exists at this period, the membrane has not been demonstrated. Moreover, it is not to be supposed that

The *sacro-iliac ligaments* are situated in front of, and behind the joint. The *anterior* set consists of a few irregular fibres, forming a short thin band, which is stretched between the anterior margins of the two auricular surfaces. The *posterior* set is composed of numerous oblique and transverse fascicles, which extend between the opposite rough surfaces of the ilium and sacrum behind the articulation, and fill up the deep part of the groove between the two bones; they are very dense and strong, and almost the whole strength of the articulation depends upon them. One of these bundles, more superficial than the others, and extending from the posterior superior spine of the ilium to the lower part of the spine of the sacrum, is known as the *oblique*, or *posterior sacro-iliac ligament.*

The sacro-ischiatic or sciatic ligaments, two in number, are not immediately connected with the articulation, but, nevertheless, add very much to its strength.

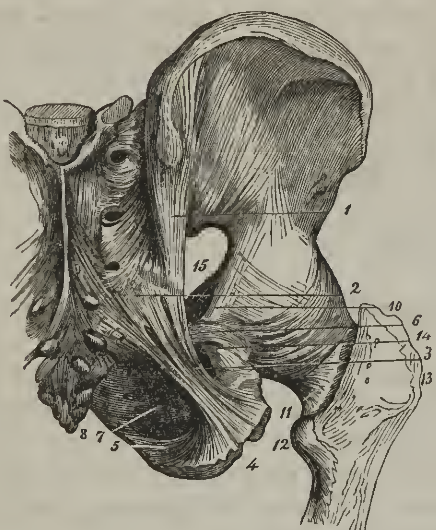
The great sacro-ischiatic ligament is situated at the lower back part of the pelvis, and extends from the posterior part of the iliac crest, the margin, and spine of the sacrum, and from the border of the coccyx to the inner side of the tuberosity of the ischium. It is triangular in shape, flattened from within outward, and consists of closely applied fibres, which converge from its internal broad extremity towards its insertion into the ischium. It is in relation behind, with the great gluteal muscle, to a part of which it gives origin, and in front, to the small sacro-ischiatic ligament, with which it is continuous at its internal extremity, and from which it is separated externally by a triangular shaped opening, known as the *small sacro-ischiatic foramen.*

The *small sacro-ischiatic ligament* is situated in front of the preceding, and in common with it, originates broadly from the lower part of the margin of the sacrum, and is inserted into the extremity of the spinous process of the ischium. It is also triangular, flattened from within outward, and directed a little obliquely outward, and downward toward its insertion. By means of these two ligaments, the sacro-ischiatic notch is converted into two foramina called the *greater* and *lesser sacro-ischiatic foramina.* The former of these openings is large, somewhat triangular, and bounded upon its three sides by the border of the sacrum below the sacro-iliac symphysis,

nature would provide such a structure before the necessity for it has occurred, that is, before the alleged increased motion has actually taken place, which is stated to exist only during parturition.

the posterior margin of the body of the ischium, and the superior edge of the smaller ligament. It gives passage to the pyriform muscle, the gluteal vessels and nerves, the great and small sciatic nerves, the sciatic artery, and the internal pudic artery, with its accompanying nerve. The smaller foramen, also triangular, is formed by the diverging borders of the two ligaments and the

Fig. 124.



1. Posterior sacro-ischiatic ligament (vertical ligament of Bichat), arising from the sacro-iliac junction. 2. Also from the sacrum and coccyx. 3. Free portion of the ligament, terminating in the ischiatic tuber at 4 and 5. 6 Lesser or anterior sacro-sciatic ligament. 7. Obturator ligament. 8. Coccyx. 9 Sacral fascicle of the posterior sacro-ischiatic ligament. 10, 11. Capsular ligament of the hip-joint. 12. Small trochanter. 13. Great trochanter. 14. Lesser sciatic notch. 15. Greater sciatic notch. 16. Posterior sacro-iliac ligament.

body of the ischium, between its spine and tuberosity, and is occupied by the tendon of the internal obturator muscle, which glides over this part of the ischium, and by the internal pudic artery and nerve, which here re-enter the pelvic cavity, having passed out of it through the larger opening.

The Pubic Articulation, commonly called the *pubic symphysis* (*symphysis pubis*), is amphi-arthrodial, and occurs between the internal extremities of the pubic bones, each of which presents a plane, vertically oval surface, cut, as it were, obliquely from behind forward and outward, so that the thickness of the interval occupied by the fibro-cartilage is greater in front than behind. The bones are bound

together by four surrounding ligaments, and the intervening plate of fibro-cartilage.

The ligaments are: 1, an *anterior*, consisting of scattered oblique and transverse fibres, forming a broad thin membranous band, which extends between the anterior edges of the articular surfaces; 2, a *posterior*, like the preceding, but thinner and more difficult of demonstration; 3, a *superior*, thin, narrow, very indistinct, and continuous with the periosteum on each side; 4, an *inferior* (triangular or sub-pubic ligament), thick and strong, flattened from before backward, triangular and composed of fibres stretched transversely between the sides of the angle of the pubic arch.

The plate of *fibro-cartilage*, which fills up the interval between the articular surfaces, is wedge-shaped, its thin edge presenting posteriorly, and in this situation is sometimes found a structure resembling a synovial membrane.* Its structure is like that of the intervertebral disks.

THE SACRO-VERTEBRAL, SACRO-COCCYGEAL, AND COCCYGEAL ARTICULATIONS.†—The *sacro-vertebral articulation* does not differ from the intervertebral generally, except in the greater thickness and wedge-shape of the fibro-cartilaginous disk, and in having an additional ligament, the sacro-vertebral, which is short and thick, and extends obliquely from the transverse process of the last lumbar vertebra to the lateral surface of the base of the sacrum, blending at its insertion with the sacro-iliac ligaments.

The *ilio-lumbar ligament* is a triangular flattened band of fibres, extending from the apex of the transverse process of the last lumbar vertebra, to the posterior extremity of the iliac crest, thus serving to strengthen this articulation as well as that between the sacrum and ilium.

The *sacro-coccygeal articulation* occurs between the small, transversely oval, convex surface on the summit of the sacrum, and the corresponding concave surface on the base of the coccyx. It is generally amphiarthrodial, a small plate of fibro-cartilage connecting the two surfaces, but sometimes this disk is wanting, and its place

* As in the case of the sacro-iliac symphysis, it has been said with as little reason, that, during pregnancy, this articulation also becomes diarthrodial by the development of a complete synovial sac between the opposed surfaces.

† These three articulations, although not belonging to the inferior extremities, are introduced here simply on account of their connection with the pelvis as a whole.

supplied by ordinary articular cartilages, and a synovial membrane, in which case the joint is, of course, diarthrodial. The proper ligaments are, an *anterior*, which consists of somewhat scattered parallel fibres extending between the anterior surfaces of the bones; and a *posterior*, attached to the posterior margin of the inferior termination of the sacral canal and the corresponding surface of the coccyx, the most superficial fibres reaching as far as the extreme point of the latter bone.

The coccygeal articulations occurring between the several pieces of the coccyx, are similar to the sacro-coccygeal, and require no separate description. The only thing remarkable about them is their tendency to become immovable, which is always the case in advanced age, except between the first and second pieces.

THE COXO-FEMORAL, OR HIP-JOINT.—This articulation belongs to the class of enarthrosis, of which it is the type, being a true ball and socket-joint. The opposed surfaces are the acetabulum, or cotyloid cavity, and the head of the femur. These have already been described in connection with the bones to which they belong, but in the recent state they present certain modifications which should be carefully noticed. The head of the femur is incrusted with a layer of cartilage, which is much thicker above than below, where it is sometimes almost entirely wanting.* The cotyloid cavity is also lined with cartilage, which is thickest near the margins, and entirely wanting at the bottom, where the depression exists for the attachment of the round ligament and the lodgement of adipose tissue. This cavity is also surrounded and deepened by a fibrous ring called the *annular* or *cotyloid ligament*, which is attached to the whole extent of its margin, and converts the notch below into a foramen, for the transmission of the vessels of the joint. This ligament is triangular prismatic, thicker above than below, and thicker at its free than at its attached edge, and consists of closely interlaced fibres of various lengths, which arise from the bony margin at different points, and are inserted into it.

Besides the mechanical arrangement of the surfaces for keeping the bones in place, which is superior to that of any of the other

* In a middle-aged female subject that I recently examined, no cartilage whatever could be detected, with the naked eye, upon the lower third of the head of the femur, but the synovial membrane seemed to be in immediate contact with the bone.

large joints of the body, the articulation is provided with a capsular, and an inter-articular or round ligament.

The *capsular ligament* (see Figs. 124, 125, and 126) represents a transverse section of a large membranous tube, which is attached by one extremity to the circumference of the acetabulum just outside the cotyloid ligament, and by the other to the anterior inter-trochanteric line of the femur in front and behind, to the neck of the bone

Fig. 125.

View of the capsular ligament, 1, which is separated from the acetabulum, and thrown back to show the manner in which it invests and conceals the neck of the femur. 2. Round ligament.

at the junction of its external third with its internal two-thirds.* A transverse division exhibits a remarkably dense structure, at least a quarter of an inch in thickness above, where the greatest strength is required, but not more than half so much below. It is also strengthened above and in front by a fascicle of fibres extending from the anterior inferior iliac spine to the base of the neck of the femur in front, which, although not in fact a separate structure, is called the *ilio-femoral ligament.*

The external surface of the capsular ligament is rough where it is in contact with the surrounding muscles; internally, it is lined by

* This insertion of the capsular ligament on the femur, must be carefully borne in mind in the diagnosis of fractures of the neck of the bone, in reference to their occurrence within or without the capsule.

the synovial membrane. When cleanly dissected, it does not present the pearly glistening appearance of fibrous structures generally, but is of a dull-white color.

The *inter-articular ligament*, frequently called the *round ligament*, is a thick, dense, cord-like bundle of fibres, extending from the pit on the head of the femur, to the bottom of the cotyloid cavity, where

Fig. 126.

Another view of the upper end of the femur, divided by a vertical section. 1, 1. Capsular ligament. 2. Inter-articular ligament, after Sir Astley Cooper.

it divides into three slips, one of which is inserted into the bottom of the cotyloid depression, and the two others into the margins of the notch below. When the articular surfaces of the bones are in contact, this ligament is lodged in the depression at the bottom of the cavity, so as not to interfere with the movements of the joint. Its only use seems to be that of a support to the vessels which go to and come from the head of the femur, for it is too long to take any part in maintaining the bones in contact. It varies considerably in shape and size, and is sometimes entirely wanting.

The *synovial membrane* lines the cotyloid cavity, the internal surface of the capsular ligament, covers the head of the femur, the whole of its neck in front, and two-thirds of it behind, and forms a tubular investment for the inter-articular ligament. It frequently

forms little fringe-like folds around the neck of the femur, whose office is not positively ascertained.

Another structure connected with the hip-joint, is the mass of fat situated in the depression at the bottom of the cotyloid cavity. This seems to perform no particular office, except that of filling up that part of the depression not occupied by the inter-articular ligament.

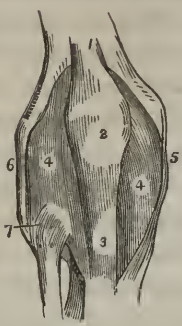
THE FEMORO-TIBIAL, OR KNEE-JOINT.—This, the most complicated articulation in the body, is an angular ginglymus. The opposed surfaces are: 1, the two condyles of the femur, which form a pulley-like surface in front, but are separated behind by the inter-condyloid fossa; 2, the two shallow glenoid cavities of the tibia with the intervening spine; and 3, the posterior face of the patella, divided by a vertical ridge into two lateral superficial concavities. These surfaces are well protected by incrusting cartilage, separated from each other by two inter-articular cartilages, and bound together by strong extrinsic and intrinsic ligaments. The extrinsic ligaments are two lateral, an anterior, and a posterior; the intrinsic, an anterior and a posterior crucial.

The *external lateral ligament* is a well-defined rounded cord, extending from a small eminence upon the outer side of the corresponding condyle near its anterior margin, to the external surface of the head of the fibula. It is vertical, lies parallel to, and directly in front of the tendon of the biceps muscle, and is in close contact above with the popliteus muscle, which originates from a small pit just below the above-mentioned eminence. The *internal lateral ligament* is broad and thin, and extends from the outer back part of the internal condyle of the femur to the inner margin of the head of the tibia. Its tibial attachment is very broad, and is covered by the tendons of the sartorius, gracilis, and semitendinous muscles, a synovial bursa intervening. It is connected by its deep surface to the synovial membrane of the joint and the internal semilunar cartilage.

The *posterior ligament* (ligament of Winslow), commonly considered as a reflected portion of the tendon of the semimembranous muscle, is a flattened bundle of ligamentous fibres, extending from the back part of the external condyle of the femur to the internal tuberosity of the tibia, crossing the back part of the articulation obliquely, and continuous at its insertion with the before-mentioned tendon.

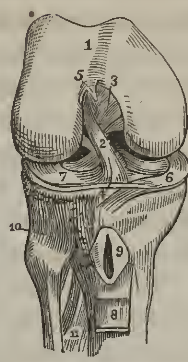
The *anterior ligament* is composed of the common tendon of the extensor muscles of the leg, the patella, and the patella ligament.

Fig. 127.



An anterior view of the ligaments of the knee-joint. 1. The tendon of the extensor muscle of the leg. 2. The patella. 3. The patella ligament near its insertion. 4, 4. The synovial membrane. 5. The internal lateral ligament. 6. The long external lateral ligament. 7. The anterior superior tibio-fibular ligament.

Fig. 128.



The right knee-joint laid open from the front, in order to show the internal ligaments. 1. The cartilaginous surface of the lower extremity of the femur with its two condyles; the figure 5 rests upon the external; the figure 3 upon the internal condyle. 2. The anterior crucial ligament. 3. The posterior crucial ligament. 4. The transverse ligament. 5. The attachment of the adipose ligament; the rest has been removed. 6. The internal semilunar cartilage. 7. The external semilunar cartilage. 8. A part of the patella ligament turned down. 9. The bursa, situated between the patella ligament and the head of the tibia; it has been laid open. 10. The anterior superior tibio-fibular ligament. 11. The upper part of the interosseous membrane; the opening above this membrane is for the passage of the anterior tibial artery.

The first and last of these three structures are properly continuations of each other, the intervening patella being only a sesamoid bone developed in the substance of the tendon, and its ligamentous continuation. *The patella ligament* (ligamentum patellæ), considered as a separate structure, is broad and thick, attached above to the apex and anterior surface of the patella, and below to the inferior part of the anterior tuberosity of the tibia. It is in relation in front with the subcutaneous areolar tissue, and behind with a mass of fat which separates it from the cavity of the joint, and with a large synovial bursa, that intervenes between it and the prominent part of the anterior tuberosity of the tibia.

A strong fibrous expansion, sometimes called the *capsular membrane*, fills up the intervals between these four ligaments, connecting them together and supporting the synovial membrane. Posteriorly, where it covers the condyles, this membrane is wanting, but here the heads of the gastrocnemius muscle make up the deficiency. It is also continuous with the fascia of the thigh and the fibrous expansion of the triceps extensor muscle.

The *crucial* or *inter-articular ligaments* are placed deep within the joint. They are very strong, and so arranged as to be relaxed by flexion of the leg, and tightened by extension. They are two in number, an anterior and a posterior, and, as their name (crucial) implies, cross each other in their direction. The *anterior* arises from a depression upon the middle of the internal surface of the external condyle of the femur, and, descending obliquely downward, inward, and forward, is implanted into the front of the spine of the tibia, sending off a few fibres to the anterior extremity of the external inter-articular cartilage. The *posterior* arises from the external surface of the internal condyle, opposite the preceding, descends downward, backward, and outward, and is inserted into the pit behind the spine of the tibia, where it is connected also with the posterior extremity of the external inter-articular cartilage; it is less oblique than the anterior, but sufficiently so to form with it an oblique antero-posterior crossing.

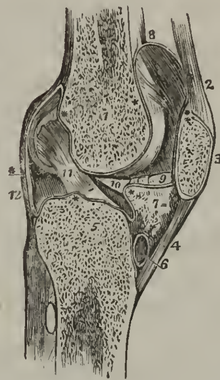
The *inter-articular cartilages*, two in number, are situated between the condyles of the femur and the concave surfaces of the tibia. They serve as a cushion, to break the ordinary pressure of the body above, and also that produced by sudden falls or blows upon the leg below.

From their crescent shape they are commonly called semilunar cartilages; they have a superior concave and an inferior plane surface, a thick, semicircular, external, and a thin, sinuous, internal edge. The *internal* of the two cartilages is elongated from before backward, and is distinctly semilunar; it is attached by an anterior ligament to the front of the spine of the tibia, and, by a posterior, to a roughness behind the insertion of the posterior inter-articular ligament. The *external* cartilage is more nearly circular, is connected in front and behind with the insertions of the inter-articular ligaments, and has also an anterior and a posterior ligament which attach it to the corresponding parts of the spine of the tibia. The latter are placed between the ligaments of the internal cartilage, and are, therefore, quite near each other. A small bundle of fibres, forming what is called the *transverse ligament*, connects the anterior extremities of the cartilages in front of the spine of the tibia. They are also connected to the corresponding lateral ligaments of the joint, and the external of the two is slightly grooved upon its margin behind for the tendon of the popliteus muscle, which crosses the posterior aspect of the joint obliquely.

The *synovial membrane*, like all other serous membranes, is a shut

sac, but its reflections are very complicated. Beginning, however, at the upper margin of the patella, we find it continued upward to the distance of about two inches between the tendon of the extensor muscles and the anterior part of the lower extremity of the femur,

Fig. 129.



A longitudinal section of the left knee-joint, showing the reflection of its synovial membrane. 1. The cancellous structure of the lower part of the femur. 2. The tendon of the extensor muscles of the leg. 3. The patella. 4. The patella ligament. 5. The cancellous structure of the head of the tibia. 6. A bursa situated between the patella ligament and the head of the tibia. 7. The mass of fat projecting into the cavity of the joint below the patella. ** The synovial membrane. 8. The pouch of synovial membrane, which ascends between the tendon of the extensor muscles of the leg, and the front of the lower extremity of the femur. 9. One of the alar ligaments; the other has been removed with the opposite section. 10. The adipose ligament left entire; the section being made to its inner side. 11. The anterior or external crucial ligament. 12. The posterior ligament. The scheme of the synovial membrane, which is here presented to the student, is divested of all unnecessary complications. It may be traced from the sacculus (at 8), along the inner surface of the patella; then over the adipose mass (7), from which it throws off the mucous ligament (10); then over the head of the tibia, forming a sheath to the crucial ligaments; then upwards along the posterior ligament and condyles of the femur to the sacculus, where its examination commenced.

spreading out upon each side beneath the large muscles, but prolonged considerably higher upon the inner than upon the outer side;* it then covers the trochlea and condyles of the femur, dips into the inter-condyloid notch, surrounds the crucial ligaments, covers the posterior ligament, and is then reflected forward upon the articular surface of the tibia, incloses the inter-articular cartilages, and descends behind the patella ligament nearly as far as the anterior tuberosity of the tibia; from this point it ascends behind the ligament and the patella, and, from the lower border of the latter, sends a triangular, flattened fold backward to the anterior extremity of the

* The presence of these two prolongations explains the swelling upon each side and above the patella, but more prominent upon the inner side, observed in collections of fluid within the joint.

inter-condyloid notch of the femur. This fold is called the *adipose ligament* (*ligamentum mucosum*), and varies in size in different individuals. Besides this, it forms several little fringe-like prolongations upon each side of the patella, which lie loose and floating in the joint; these are sometimes, but improperly, called the *alar ligaments.*

The *articular adipose tissue* forms a considerable mass behind the upper part of the patella ligament, which it renders prominent during extension of the leg. It is covered posteriorly and laterally by the synovial membrane, and is drawn during flexion by the adipose ligament, into the space between the condyles of the femur and the upper surface of the head of the tibia.

Peroneo-Tibial Articulations.—These are two in number, a superior and an inferior, both diarthrodial.

The *superior* articulation occurs between the upper extremity of the fibula and the back part of the external tuberosity of the tibia, these bones presenting two flat oval surfaces covered with cartilage, provided with a simple synovial membrane, and bound together by an *anterior* and a *posterior ligament.* These two ligaments are oblique in their direction, and attached to the adjacent parts of the two bones in front of and behind the articulation. The *synovial membrane* is sometimes only a prolongation of that of the knee-joint, but ordinarily a separate sac.

The *inferior* articulation is formed between the internal surface of the lower extremity of the fibula, which here presents a transversely oblong convex facet, and the external side of the extremity of the tibia, whose articular surface is correspondingly concave and continuous with the tarsal surface of the bone. The ligaments are: 1, an *anterior*, which is of a pearly white color, thick and strong, and extends obliquely downward and outward from the tibia to the anterior surface of the head of the fibula; 2, a *posterior*, like the anterior in its direction, but broader and somewhat triangular in shape; 3, an *interosseous*, consisting of numerous short dense fascicles, extending between the contiguous rough triangular surfaces of the bones immediately above the articulation. The *synovial* membrane is a prolongation of that of the ankle-joint.

Between the superior and inferior articulations, the tibia and fibula are separated by a long narrow interval occupied by a strong *interosseous aponeurosis.* This membrane assists in keeping the two bones together, but is of more special service in increasing the surface

for muscular attachments. It is perforated above and below for the passage of the tibial and peroneal vessels.

THE TIBIO-TARSAL OR ANKLE-JOINT.—The ankle-joint is an angular ginglymus formed between the tibia and fibula on the one hand, and the astragalus on the other. The superior articular surface is transversely oval, concave, terminated at its extremities by the internal and external malleolar processes, traversed about its middle by a broad, slightly elevated, rounded, antero-posterior ridge, and bordered before and behind by the corresponding tibio-peroneal ligaments. The surface of the astragalus is quadrangular, elongated, and convex antero-posteriorly, and slightly concave from side to side ; it is, in fact, a true trochlea or pulley, the vertical sides of which are also articular where they correspond to the two malleoli. These surfaces are covered with cartilage and synovial membrane, and are bound together by three ligaments, namely, two lateral, and an anterior.

The *internal lateral ligament* is a very strong, flat bundle of fibres, which originate by a narrow extremity from the lower border of the internal malleolus, and spreads out to be inserted into the inner side of the astragalus, the calcis, and the scaphoid. The *external lateral ligament* consists of three separate bundles, which diverge from their origin upon the fibular malleolus ; the *anterior*, very short, to be inserted into the astragalus in front of its lateral facet ; the *middle*, long and rounded, into the external side of the calcis ; and the *posterior*, the strongest of the three, into the posterior border of the astragalus, just above the groove for the tendon of the long flexor muscle of the great toe.

The *anterior* or *tibio-tarsal ligament* is a broad, thin, ligamentous membrane, extending from the anterior margin of the articular surface of the tibia to the corresponding part of the pulley-like surface of the astragalus.

The *synovial membrane* covers the superior and lateral surfaces of the astragalus, the articular faces of the anterior and lateral ligaments, the concave surface formed by the tibia and fibula, and sends a prolongation to the inferior tibio-peroneal articulation. It is supported posteriorly, where there is no distinct ligament, by a few scattered aponeurotic fibres and areolar tissue.

TARSAL ARTICULATIONS.

The bones of the tarsus are articulated with one another in a very intricate yet most beautiful manner, forming by their union a solid elastic arch for the reception of the weight of the body. They are arranged into two sets, the first composed of the astragalus and calcaneum, and the second of the cuboid, scaphoid, and the three cuneiform bones. The articulations comprise, therefore: 1, the articulations of the component bones of each set; and, 2, the articulation of the two sets together.

Articulation of the Bones of the First Set.—The *astragalo-calcaneal articulation* is a double diarthrosis, the two bones presenting each two smooth facets, an anterior and a posterior, separated by a deep groove, and provided with articular cartilages and synovial membranes. The principal means of union is a strong *interosseous ligament*, which consists of numerous short, thick, vertical, and oblique fascicles, and fills up nearly the whole of the groove between the two articulations. Besides this, there is a *posterior* and an *external ligament;* the former is short and narrow, and connects the posterior border of the astragalus with the upper surface of the calcaneum; the latter is quite small, and extends from the under surface of the astragalus to the external side of the calcaneum.

Articulations of the Bones of the Second Set.—The scaphoid bone articulates with the three cuneiform by its anterior convex surface, which is divided into three triangular facets, covered with cartilage and furnished with one common synovial sac. The ligaments are two in number, a *dorsal* and a *plantar*, for each cuneiform bone; the former strong and well defined, the latter irregular and indistinct.

The cuneiform bones are articulated with each other by their lateral surfaces, which are smooth and provided with cartilage behind, but rough in front for the attachment of *interosseous ligaments*. They have also *dorsal ligaments*, which are strong transverse bands extending between the upper surfaces of the bones; and *plantar ligaments*, consisting of a few scattered fibres, which are really a part of the strong interosseous bundles.

The external cuneiform and cuboid bones are joined together very much like the preceding, *dorsal* and *interosseous ligaments* forming the bond of union.

The scaphoid and cuboid bones are also connected together by *dorsal*, strong *interosseous*, and *plantar ligaments*, and sometimes,

but not always, present a small diarthrosis with the usual articular cartilage and synovial membrane.

Articulations of the First and Second Set with one another.— These are two in number, the astragalo-scaphoid and calcaneo-cuboid.

1. The *astragalo-scaphoid articulation* is a true ball and socket joint, the head of the astragalus being received into a corresponding cavity, formed above, by the posterior surface of the scaphoid bone, and below, by the anterior facet of the calcaneum and the calcaneo-scaphoid ligament. The only ligament proper to the articulation is a broad membranous band, called the *astragalo-scaphoid*, situated upon the dorsum of the foot, and extending from the anterior margin of the astragalus to the superior surface of the scaphoid bone. The *calcaneo-scaphoid ligament*, which completes the articular cavity below, is stretched, as its name indicates, between the scaphoid bone and the calcaneum, being attached to the lower surface of the former and the anterior extremity of the latter ; it is remarkably strong, triangular in shape, flattened from above downward, and in contact above with the synovial membrane of the joint, and below with the tendon of the posterior tibial muscle. Taking into consideration its use in binding the bones together, supporting the head of the astragalus, and through it the whole weight of the body, and in giving to the arch of the foot that elasticity for which it is remarkable, and which is so absolutely necessary to locomotion, it is one of the most important and interesting ligaments in the body.

Another ligament, called the *superior calcaneo-scaphoid*, is also considered as assisting in keeping the head of the astragalus in its place. It is situated upon the dorsum of the foot, deep in the fossa upon the outer side of the astragalus, and extends from the inner side of the calcaneum to the external side of the scaphoid.

2. The *calcaneo-cuboid articulation* is diarthrodial by mutual reception, the articular surface of the calcaneum being concave from above downward and convex transversely, and that of the cuboid the reverse. The opposed surfaces are provided with articular cartilage and a synovial membrane, and are bound together by a superior, an inferior, and an internal ligament. The first of these, the *superior calcaneo-cuboid ligament*, is broad and thin, and extends between the adjacent margins of the bones above the articulation. The *internal*, short, narrow, and quadrangular, is situated in the fossa upon the outer side of the astragalus, where it is partly united with the superior calcaneo-scaphoid ligament. The *inferior* is the longest and probably the strongest of the tarsal ligaments, and may be

divided into two parts, a superficial and a deep-seated; the former arises from the middle of the under surface of the calcaneum, passes horizontally forward, and is inserted into the posterior margin of the groove of the cuboid, and by a prolongation of some of its fibres into the bases of the third and fourth metatarsal bones; the latter, separated from the other by areolar and adipose tissue, is broad and strong, and extends from the anterior inferior surface of the calcis to the adjacent part of the cuboid bone behind the groove.

These two articulations (the astragalo-scaphoid and calcaneo-cuboid) are directly upon a line with each other, rendering the partial amputation of the foot in this situation quite easy.

The Tarso-Metatarsal Articulations.—The anterior extremity of the tarsus is articulated by diarthrosis to the bases of the five metatarsal bones; but the line of union is very irregular, owing to the projection forward of the first and third cuneiform bones, which form with the second a deep mortise-like notch for the reception of the base of the second metatarsal bone.

The base of the first metatarsal bone is in contact with the internal cuneiform; that of the second with the middle, and, laterally, with the internal and external cuneiform bones; the third with the external cuneiform; and the last two with the cuboid bone. The ligaments are of three kinds, namely—dorsal, plantar, and interosseous.

The *dorsal ligaments* are flat and thin, and extend from the anterior margin of the tarsus to the adjacent part of the metatarsus. They are seven in number, each metatarsal bone receiving one, except the second which has three, namely, one from the cuneiform bone upon which it rests, and one from each of the two others between which it is placed.

The *plantar ligaments* are divided into two sets, the *straight* and the *oblique*. The former are five in number, and extend directly from the bones constituting the anterior extremity of the tarsus to the bases of the corresponding metatarsal bones; as a general rule, they are less strong than the dorsal, except the first, which is large and well defined. The *oblique* set numbers only three, the first extending from the internal cuneiform to the second metatarsal bone, the second from the first cuneiform to the third metatarsal, and the third from the external cuneiform to the fifth metatarsal.

The *interosseous ligaments* are placed deeply between the bones, and consist of numerous short, strong fascicles surrounding the articular facets, and extending between the contiguous rough surfaces.

The Metatarsal Articulations.—The metatarsal bones are bound together both at their tarsal and phalangeal extremities. In the former situation, all of them, except the first, present lateral articular facets, which are covered with cartilage, and provided with prolongations of synovial membrane from the tarso-metatarsal articulations. They are united by dorsal and plantar transverse bands and by interosseous fascicles extending between the rough surfaces of the contiguous bones. The phalangeal extremities of the bones are bound together by the *transverse ligament of the metatarsus*, which is situated upon the plantar surface of the bones and unites them loosely together. Between the heads of the bones are prolongations of synovial membrane, but no articular facets.

The Metatarso-Phalangeal and the Phalangeal Articulations.—These articulations do not differ materially from those of the corresponding parts of the hand, and it is not, therefore, necessary to repeat the description.

PART III.

DISSECTIONS.

INTRODUCTION.

It is presumed in the following pages that the student has already acquired some knowledge of general anatomy, and of the bones; otherwise, let him be assured, indeed, the slightest reflection of his own should assure him, that dissection will be of but little advantage. He should first study with the aid of butchers' meat or other convenient specimens, and from some outline of general anatomy, the distinctive characters of the several tissues that compose the body, until he is able to recognize them at sight; next, he should learn accurately upon the skeleton, the situation, relations, and special marks of the different bones; and then, but not until then, will he be prepared to appreciate properly the work which he is about to commence. These preliminary studies being finished, the student should provide himself with an apron and an ordinary case of dissecting instruments; and, since the supply of anatomical material is not usually abundant enough to justify the dissection of one or two parts, or a single class of structures to the rejection of the rest, it becomes necessary to preserve the subject as long as possible from putrefaction. This may be accomplished by injecting the arteries with some antiseptic fluid, such as turpentine, solutions of common salt, nitrate of potash, arsenic, acetate or sulphate of alumina, &c.; but of all these, and several other substances which I have employed, I give decided preference to the *chloride of zinc.* The usual mode of preparing and using this material is to saturate chlorohydric acid with metallic zinc,* adding to a pint of the neutral mixture thus obtained a gallon of rain-water, and injecting it by means of a large brass syringe into one of the common carotid arteries, at about the middle of the neck. After a few minutes, this may be followed by enough hot tallow to fill the larger vessels, and thus render them more easy of dissection. The

* The block zinc of commerce is the purest and best.

only objection to the chloride of zinc is the discoloration, or rather the destruction of color, that it causes in the soft parts, bringing them generally to an almost uniform dirty white or gray color. Its powerful antiseptic and disinfectant properties, however, more than compensate for this defect. Where the object is to study the smaller arteries, or to make a dried preparation, the common cold injection, consisting of two parts of white lead ground in oil to one of Venice turpentine, or rosin-varnish, or the hot injection, consisting of two parts of wax to one of tallow, are the best. It is also necessary to adopt some plan by which the greatest economy of material and labor may be effected, and the greatest information derived from a single subject; for, as just intimated, it is not often possible, in this country, to study anatomy systematically, that is, to take up one class of structures at a time, and devote an entire subject to each. Hence it is necessary to study the body by regions, and examine every structure as it is met with, commencing with the most convenient parts, and with those organs which soonest decay. The plan which I have almost uniformly pursued during the past few years, and which is very generally followed in the schools of medicine in this country, is the one here presented, and the student is advised to adhere to it as closely as possible.

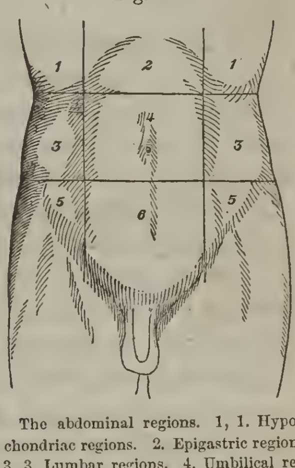
Lastly, if the student desires to overcome those natural prejudices against dissecting which all feel in a greater or less degree, and to cultivate a genuine love for the study of anatomy, he must never forget the absolute necessity of scrupulous *cleanliness*, cleanliness not only from ordinary dirt, but from everything that may mar the beauty of the part exposed. It is well known that students generally do not take that interest in practical anatomy that the importance of the subject requires, and this distaste is produced in no way so often as by a want of neatness in the dissecting room. Dissecting is filthy and repulsive only when made so by those engaged in it. Those who may use this book as a guide to the study of practical anatomy, are requested to make it an inviolable rule, when work for the day is over, to cut off all the useless ends of muscles, skin, &c., sponge and wipe the whole surface of the body, remove it from the table, and cover the exposed parts with a cloth moistened with a solution of common salt, or very dilute chloride of zinc.

Directions for holding the knife and forceps, for removing the several structures as they are met with, and such other directions as are thought necessary, will be found incorporated with the text.

THE ABDOMEN.

The abdomen comprises all that part of the trunk which lodges the digestive organs, and should be examined progressively from without inward, commencing with its anterior and lateral walls. For convenience of reference and study, it is divided into nine different regions, which may be marked off on the subject in the following manner: Draw a line from the lower margin of the cartilage of the ninth or tenth rib on one side, to the corresponding point on the opposite side, and another between the highest points of the crests of the iliac bones; then intersect these by two vertical lines, extending on each side from midway between the superior anterior spinous process of the ilium and the spinous process of the pubis, directly upward to the margin of the thorax, where they will usually rest on each side over the cartilage of the eighth rib. The names of the regions thus defined are, commencing with the superior middle, the *epigastric*, below this the *umbilical*, and next the *hypogastric;* upon the sides, commencing above, the *right* and *left hypochondriac*, the *right* and *left lumbar*, and the *right* and *left iliac*.

Fig. 130.



The abdominal regions. 1, 1. Hypochondriac regions. 2. Epigastric region. 3, 3. Lumbar regions. 4. Umbilical region. 5, 5. Iliac regions. 6. Hypogastric region.

The anterior and lateral walls of the abdomen extend from the lower margin of the thorax to the crest of the ilium and the pubes, and on each side nearly as far back as the lumbar vertebræ. They consist entirely of soft structures, and should be dissected as follows:—

Dissection.—Let the subject rest on its back with a block under the loins to render the parts tense, and, if this is not sufficient for the purpose, inflate

the abdominal cavity with a blowpipe, introduced through an oblique opening made with a narrow-bladed knife, immediately below the point of the ensiform cartilage. Next, divide the skin by a median incision curved from over the lower third of the sternum to the pubic symphysis; and from the extremities of this make two lateral incisions, a superior extending obliquely across the thorax to the extremity of the twelfth rib, and an inferior extending to the anterior superior spinous process of the ilium, and thence along the crest of this bone as far as its posterior third. If the subject is a male, the lower incision on one side may be made from a point midway between the umbilicus and pubic symphysis to the before-mentioned spinous process, and thence along the iliac crest, thus marking off a triangular space below containing the parts concerned in inguinal hernia, which should be left untouched until after the remainder of the anterior and lateral walls has been completely dissected. Commencing now at one or other of the angles formed by the incisions, the skin *alone* should be removed in one entire flap and allowed to hang from the side posteriorly, care being taken to cut close to its under surface if the subject is much emaciated, to avoid removing any of the subjacent areolar tissue, which is the first structure brought into view.

The *subcutaneous areolar tissue*, which is spread over the whole surface of the body, is here, more than elsewhere, subject to a deposition of fat, which in corpulent subjects, especially females, often forms a layer an inch or more in thickness. In emaciated persons, this tissue is thin and delicate, and constitutes only a bond of union between the skin and the subjacent muscles. The small artery called the *superficial epigastric*, with its accompanying vein, ramifies in its substance over the iliac region on each side, obliquely upward and inward.

The under surface of this tissue is somewhat condensed to form the anterior layer of the sheath of the abdominal muscles. It is generally considered as a separate structure under the name of the *superficial fascia*, but when the adipose deposit is wanting, it is often impossible to make this distinction.

Like the areolar layer, of which it is a part, this fascia is not confined to the abdomen, but is continued over the thorax, back, thighs, &c., closely investing the structures beneath, but varying in its thickness and density, according to the amount of pressure which it may sustain. In dissecting the flap reserved to study the anatomy of inguinal hernia, this fascia will claim particular attention.

Dissection.—To remove the subcutaneous areolar tissue and superficial fascia, commence next the cut edge of the skin upon the thorax, and within about three inches of the median line, and by repeated strokes of the scalpel turn it downward and outward in one continuous layer. In performing this dissection, it should be known beforehand that the fibres of the external oblique muscle, which is the structure next brought into view, are directed downward and inward, and to make a clean dissection, it is absolutely neces-

sary to follow the same direction with the knife. In fact, the beginner should, at the outset, make it an inviolable rule always to dissect a muscle in the direction of its fibres, for, however skilful he may be in the use of the knife, he can never make a neat dissection in any other way. In removing the fascia over the lower part of the sternum, great care is necessary to avoid taking up, at the same time, the tendon of the external oblique muscle, which here covers the superior extremity of the straight muscle in the form of a thin membranous expansion. The same caution is necessary along the whole line of union between the muscular and tendinous fibres, and to avoid this accident it is best always to keep the dissection over the latter considerably in advance.

If the fascia has been exposed only throughout one side of the abdomen, it may be turned down from the other along with the skin.

In performing this dissection, several small vessels, and some cutaneous branches of the lumbar and lower intercostal nerves will be unavoidably divided.

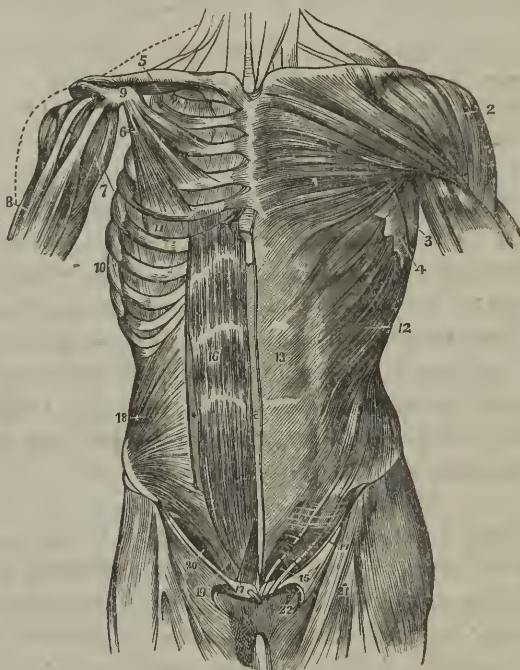
The muscles of the anterior and lateral abdominal walls are in pairs, and for the most part spread out in layers with thin but strong membranous tendons. Those forming the lateral walls are three in number, namely, the *external oblique*, *internal oblique*, and *transverse muscles*. They are placed one above another in the order here mentioned, but are separated by thin laminæ of condensed areolar tissue (inter-muscular fasciæ or septa), inclosing by their tendons in front the anterior group, which consists of only two, the *straight* and *pyramidal muscles*.

The EXTERNAL OBLIQUE MUSCLE (Fig. 131, 12) derives its name partly from its situation, and partly from the obliquity of its fibres. It is broad, thin, and irregularly quadrilateral, and is attached above to the external surfaces of the seven or eight inferior ribs, a short distance from their cartilages, by as many fleshy slips, of which the five superior indigitate with the great serrated muscle, (4) (a lateral muscle of the thorax), and the three inferior with the latissimus, (3) (a muscle of the back). From these points the fibres descend with different degrees of obliquity. The posterior are inserted by short, white, tendinous fibres into the anterior half or two-thirds of the outer lip of the crest of the ilium. The middle and anterior fibres by means of a strong, white, fibrous membrane (13), which is the tendon of the muscle, are inserted into the superior anterior spinous process of the ilium, the spinous process and crest of the pubis, and into the tendon of the corresponding muscle of the opposite side, from the pubic symphysis to the ensiform cartilage. At this insertion along the median line, the aponeurosis or tendons of all the three lateral abdominal muscles meet and form a *white line* (linea alba),

which extends the whole length of the anterior wall of the abdomen from the sternum to the pubis, being interrupted a little below its middle by the umbilicus or navel.

When the aponeurosis of this muscle is stretched from the superior anterior spinous process of the ilium to the spine of the pubis, it is

Fig. 131.



The muscles of the anterior aspect of the trunk; on the left side the superficial layer is seen, and on the right the deeper layer. 1. The great pectoral muscle. 2. The deltoid muscle. 3. The anterior border of the latissimus muscle. 4. The indigitations of the great serrate muscle. 5. The right subclavian muscle. 6. The small pectoral muscle. 7. The coraco-brachial muscle. 8. The upper part of the biceps muscle, showing its two heads. 9. The coracoid process of the scapula. 10. The great serrate muscle of the right side. 11. The external intercostal muscle of the fifth intercostal space. 12. The external oblique muscle. 13. Its tendon or aponeurosis; on the left of this number is the semilunar line, and on the right, the middle white line (linea alba). 14. Poupart's ligament or the crural arch. 15. The external inguinal or abdominal ring; the crescentic opening to the right of 15 is the sphenous opening in the femoral aponeurosis. 16. The straight abdomiual muscle of the right side brought into view by the removal of the anterior segment of the sheath formed by the tendons of the lateral broad muscles. 17. The pyramidal muscle. 18. The internal oblique muscle. 19. The conjoined tendon of the internal oblique and transverse muscles. 20. The arch formed by the lower border of the internal oblique and transverse muscles, from beneath which the spermatic cord has been removed.

thickened and turned in upon itself, so as to form a well-defined margin, known as *Poupart's ligament* or the *crural arch* (14). A continuation of the same tendinous fibres is inserted for about an inch

into the anterior extremity of the ilio-pectineal line, forming what is called *Gimbernat's ligament;* but this cannot be seen until the muscle is turned down.

Immediately above and a very little external to the spinous process of the pubis, the aponeurosis presents an oval-shaped opening, called the *external abdominal ring* (15), which gives passage in the male to the spermatic cord, and in the female to the round ligament of the uterus. This opening is formed by a separation of the tendinous fibres, which, it will be seen, commence some distance above, but are covered in as far as the opening by strong intersecting fibres, which arise from the crural arch, a short distance below the anterior superior spine of the ilium, and are directed in a curved manner upward and inward toward the middle white line of the abdomen. The lateral margins of the ring are often called its pillars or columns, of which the inner or superior is attached to the pubic crest and symphysis, interlacing with the fibres of the opposite muscle, while the outer or inferior is formed principally by the internal extremity of the crural arch. From these margins, a thin membranous expansion, named the spermatic, or inter-columnar fascia, is prolonged downward upon the spermatic cord.

Relations.—The external oblique muscle is covered throughout by the subcutaneous areolar tissue, and is slightly overlapped behind by the anterior margin of the latissimus muscle. It lies upon the anterior extremities and cartilages of the seven or eight inferior ribs, and their intercostal muscles, and upon the whole extent of the internal oblique muscle, from which it is separated only by a thin septum of condensed areolar tissue.

Besides the middle white line formed by the intersection of the opposite muscles, two others, much less distinct, may be seen in this view, extending on each side from the inferior margin of the thorax, a little distance outside of the ensiform cartilage, towards the inner extremity of the crural arch. They are formed by the union of the fleshy and aponeurotic portions of the muscle, and from their slightly curved direction are called the *semilunar lines.*

Dissection.—The external oblique muscle should now be removed, together with the inter-muscular fascia that separates it from the internal oblique, and in order to dissect in the course of this latter muscle, whose fibres run obliquely from below upward and forward, it is necessary to proceed differently on the two sides. *On the right side,* the tendon of the external oblique should be divided by an incision extending from the spine of the ilium directly across to the semilunar line and turned upward, cutting it from the crest of the

ilium and along the semilunar line* in the progress of the dissection, taking care to carry along with it the subjacent fascia, which is here very thin. When the dissection has reached the margin of the thorax, the muscle may be divided across, or removed entirely by detaching its different heads. The little flap of tendon left below may then be turned down and allowed to remain. *On the left side*, the muscle should be cut across the direction of its fibres upon the thorax, and the removal commenced posteriorly, turning the whole muscle forward as far as the semilunar line, where it may be cut off. The small fleshy flap left upon the thorax may be subsequently removed by cutting loose its attachment to the ribs.

The INTERNAL OBLIQUE MUSCLE (18), broad and thin like the preceding, originates† from the lumbar aponeurosis,‡ the anterior two-thirds of the middle lip of the iliac crest, and the external third of Poupart's ligament. It is inserted: 1, by tendinous and fleshy fibres into the anterior two-thirds of the lower margin of the thorax; 2, through a strong aponeurosis into the whole length of the middle white line (linea alba); and, 3, by means of a flattened tendon common to this and the subjacent muscle, and hence called the "conjoined tendon of the internal oblique and transverse," into the crest of the pubis, and for about half an inch, into the ilio-pectineal line directly behind the external abdominal ring. It will thus be seen that the fibres of the muscle diverge from their origin; the posterior passing almost vertically upward, and the inferior downward and inward. The latter form a curved margin or arch (20), beneath which the spermatic cord passes obliquely toward the external ring, where it is placed directly in front of the conjoined tendon.

The aponeurosis of the internal oblique muscle cannot be examined until the straight muscle is dissected, when it will be found to divide into two laminæ, one of which lies in front of this muscle its whole length, while the other is situated behind, and is deficient in the lower fourth of the abdomen.

Connected with the inferior margin of the internal oblique muscle, and partly seen in this dissection, is the *cremaster muscle*,§ to be described hereafter. It consists of a few pale, scattered, fleshy fibres, which have their origin from the crural arch immediately below that of the internal oblique muscle, and, passing off upon the

* The object in dividing the muscle along the semilunar line is to leave for the present the sheath of the straight muscle untouched.

† The *origin* of a muscle is its usual fixed point of attachment, as distinguished from its *insertion*, which is usually its point moved or upon which it acts.

‡ This structure cannot be seen in this dissection.

§ Not shown in Fig. 131.

spermatic cord, are reflected upon it and around the testicle, in the form of loops, whose inner extremities are inserted into the crest of the pubis.

Relations.—The internal oblique muscle is covered by the external oblique, lies upon the transverse, and is slightly overlapped behind by the latissimus muscle. Its most important relations, however, are that with the external inguinal ring, the inguinal canal, and the spermatic cord, which will be hereafter noticed in connection with the anatomy of hernia.

Dissection.—To remove the internal oblique muscle of the *right* side, divide it transversely across from the outer extremity of the crural arch to the semilunar line, and turn the flap upward, taking care to remove with it the subjacent fascia, which is here very thin. As the dissection progresses, it will be necessary to cut the muscle along the semilunar line, iliac crest, and lumbar aponeurosis, and, finally, along the margin of the thorax. The student may have some difficulty in distinguishing the internal oblique from the transverse muscle at the point of incision, as they are here closely connected; but if the branches of the circumflex artery of the ilium with their accompanying veins, which ramify between the two near the iliac spines, are taken as the guide, there will be no difficulty. That portion of the muscle below the incision is frequently so intimately blended with the transverse that it is useless to attempt to separate the two.

Upon the *left* side, the dissection may be commenced at the margin of the thorax near the superior termination of the semilunar line; from this point the muscle and subjacent fascia should be turned down, detaching them from the ribs and along the semilunar line in the course of the fibres underneath.

In removing the internal oblique muscle several branches of the lumbar nerves are necessarily divided. The most important of these is one that lies between this and the transverse muscle, near the spinous process of the ilium, sending filaments to the outer part of the thigh and scrotum, and hence called the *ilio-scrotal* or *superior musculo-cutaneous nerve*.

The transverse muscle (transversalis) is the most deeply seated of the lateral broad muscles of the abdomen, and of a much less firm consistence and bright red color than the two preceding. It originates from the margin of the thorax, the lumbar aponeurosis, the anterior two-thirds of the inner lip of the crest of the ilium, and the outer third of Poupart's ligament; from these points the fibres pass for the most part transversely, and terminate in a broad aponeurosis, which is inserted into the ensiform cartilage, white line, and crest of the pubis. The lowermost fibres, however, curve downward, and are inserted by means of the conjoined tendon into the crest of the pubis and ilio-pectineal line. The aponeurosis, in the upper three-fourths of the abdomen, passes behind the straight muscle in connection with the posterior layer of the internal oblique, but in the lower

fourth, it lies in front along with two other layers beneath which it is placed.

Relations.—The transverse muscle lies upon the sub-peritoneal or transverse fascia, and is covered by the internal oblique, a thin fascia intervening. At the inferior part of the abdomen, where the muscle passes from the crural arch to the crest of the pubis, it crosses the track of the inguinal canal obliquely, but has no immediate relation with it.

Dissection.—The transverse muscle must be left in its position until the straight and pyramidal muscles have been dissected. To expose these, the sheath formed by the tendons of the preceding muscles should be divided a short distance from the middle white line (linea alba), the incision extending from the margin of the thorax to the pubis, and the two flaps being turned aside. Except at certain transverse tendinous lines, the sheath is not very closely connected with the muscle. The same mode of dissecting is applicable to both sides.

The straight abdominal muscle (rectus abdominis) (Fig. 131, 16), so called from the vertical direction of its fibres, extends in front of the abdomen, from the pubis to the thorax. It is long and flat, broader above than below, and occupies the partial sheath formed by the tendons of the lateral broad muscles. It originates from the crest of the pubis by a broad flat tendon, ascends nearly parallel with its fellow of the opposite side, and is inserted fleshy into the costo-xyphoid ligament, and into the cartilages of the fifth and sixth ribs, and sometimes, also, into those of the fourth and seventh. The fleshy fibres do not extend the whole length of the muscle, but are divided into sections, of which there are generally four or five. These sections are connected with each other by tendons, called *tendinous intersections*, which run a zigzag course across the muscle, but do not always involve its whole thickness or breadth. One of these transverse intersections or lines is usually formed at the umbilicus, another, opposite the extremity of the ensiform cartilage, and a third, between these two. If more than three exist, the others generally occur below the umbilicus.

Relations.—The superior extremity of the muscle rests upon the cartilages of the fifth, sixth, seventh, eighth, and ninth ribs, and the corresponding intercostal muscles: below the margin of the thorax, as far down as midway between the umbilicus and pubis, it is inclosed by the aponeurotic laminæ already mentioned, and in the rest of its extent, it lies between these laminæ and the peritoneum (the serous membrane lining the abdomen), a thin layer of loose areolar tissue

intervening. Its tendon is crossed obliquely in front, by the pyramidal muscle, and is continuous at its outer margin with the true transverse fascia.

The muscle is separated from its fellow by the white line (linea alba), which is much broader above the umbilicus than below it.

The PYRAMIDAL MUSCLE (pyramidalis) (17) is situated in front of the lower extremity of the preceding, and, as its name indicates, is somewhat pyramidal in shape, with its base presenting downward. It originates broad and fleshy from the crest of the pubis, ascends, and is inserted into the white line, midway between the umbilicus and pubic symphysis. The external fibres of the muscle are very oblique, but the internal are nearly vertical. The muscle varies in size in different individuals, and is not unfrequently absent upon one or both sides.

DISSECTION.—The straight muscle may now be divided near its middle, and the two pieces turned back and removed from the subject. In dissecting off the lower portion, the abrupt transversely lunated margin of the sheath, where it terminates behind between the umbilicus and pubis, will be distinctly seen, and also the epigastric artery, as it ascends obliquely inward, behind the muscle, and within the sheath, giving branches to all the adjacent parts. Two veins, one on each side, accompany the artery.

ACTION OF THE ABDOMINAL MUSCLES.—The use of the abdominal muscles is threefold: 1. They form a support and protection to the contents of the abdomen; 2. By compressing the organs within, they assist in defecation, micturition, parturition, and the other mechanical functions which it is the office of some of these organs to perform; 3. They flex the upper part of the body upon the pelvis, and *vice versa;* rotate it to one side or the other, depress the ribs, and thus aid in respiration, &c., according to the particular muscles brought into action. The internal and external oblique muscles depress the ribs, flex the upper part of the trunk on the pelvis, or conversely compress the abdominal viscera, and rotate the body to one side or the other. The transverse are principally employed in diminishing the cavity of the abdomen, but, through their attachment to the ribs, they also assist in respiration. The straight muscles act most powerfully in flexion of the trunk, in which they are assisted by the pyramidal, whose special office is to make tense the aponeurosis in the median line.

DISSECTION.—The cavity of the abdomen should now be laid open by dividing the remaining structures, from the point of the sternum to the

pubis, intersecting this incision by a transverse one, about midway between the thorax and pelvis.

Before proceeding, however, to an examination of the contents of this cavity, the triangular flap, that has been reserved for the study of the parts concerned in inguinal hernia, should be carefully dissected.

ANATOMY OF INGUINAL HERNIA.

Protrusion of the abdominal viscera is most liable to take place in the inguinal region, or, as it is commonly called, the groin. It forms the lowest part of the abdomen upon either side of the median line, and for the purpose of dissection, may be marked off by a line drawn from the superior anterior spinous process of the ilium, to midway between the umbilicus and pubis, and thence vertically downward to the latter point, forming thus, two sides of a triangle, of which the third is formed by the flexure of the thigh.

Dissection.—The parts having been made tense by means of hooks, commence at the superior internal angle of the triangular flap, and dissect off the skin, turning it downward and outward. Next, evert the subcutaneous areolar tissue, or superficial fascia, as it is here called, as far as Poupart's ligament, dissecting it clean from the tendon of the external oblique, taking care at the same time not to remove the spermatic fascia where it passes from the margins of the external ring over upon the spermatic cord. This having been done, and the adhesion of the deep surface of the fascia to the crural arch noted, dissect off the tendon of the external, and the fleshy fibres of the internal oblique muscle, as they arch over the inguinal canal to reach the conjoined tendon, will be brought into view; also, the origin of the cremaster muscle, and, lying close to Poupart's ligament, the scrotal branch of the ilio-scrotal nerve on its way to the external ring. Next, turn down the fleshy and aponeurotic flap formed by the internal oblique and transverse muscles, taking great care to cut close to the under surface of the latter muscle, in order to avoid wounding the subjacent fibrous membrane, called the transverse fascia. In the fifth place, dissect down the transverse fascia and the lower extremity of the straight muscle, to the outer margin of which it is attached, together with the epigastric artery. Lastly, the peritoneum should be divided so as to expose its internal surface.

The dissection having been completed, the student should now proceed to examine the several structures, commencing with the common integument or skin.

1. The skin of the groin is soft and thin, covered with scattered hairs, and abounding in sebaceous follicles. Beneath it may be felt the lymphatic glands, which are quite numerous in the lower part of this region, the crural arch, and, in the living subject, the pulsations of the femoral artery.

2. The SUPERFICIAL FASCIA, as before mentioned, extends over the whole surface of the abdomen, around to the spine, over upon the thorax, down upon the thighs, and into the scrotum. It may be separated into two distinct layers, of which the external is loose and open in its texture, and always more or less loaded with fat, and the internal is deep, thin, but close and firm, forming the external lamina of the sheath of the external oblique muscle. In passing over upon the anterior surface of the thigh, this deep layer becomes adherent to the crural arch, and thus arrests the spreading of urinary infiltrations of the perineal and abdominal subcutaneous areolar tissue. Several small vessels ramify through the substance of the superficial fascia, of which the principal is the superficial epigastric artery with its two accompanying veins: the former, a branch of the femoral artery, ascends from the front of the upper part of the thigh to be distributed to the skin of the abdomen, but is too small to claim particular notice.

The *superficial inguinal lymphatic* glands are also contained within this fascia, forming two separate groups, one above, and the other below the inner third of Poupart's ligament. The former receive the superficial lymphatic vessels of the penis and lower part of the abdomen, and are interesting as being the seat of syphilitic bubo.

The superficial fascia assists in strengthening the walls of the abdomen, and by its elasticity aids them in contraction after prolonged distension. It forms the second covering, from without, to hernial tumors that protrude externally to the abdominal muscles in this situation, in which case, it is much more dense and strong than in its natural relations.

3. The *tendon* or *aponeurosis of the external oblique muscle* is situated beneath the superficial fascia, and is by far the strongest lamina of the abdominal walls in this region.

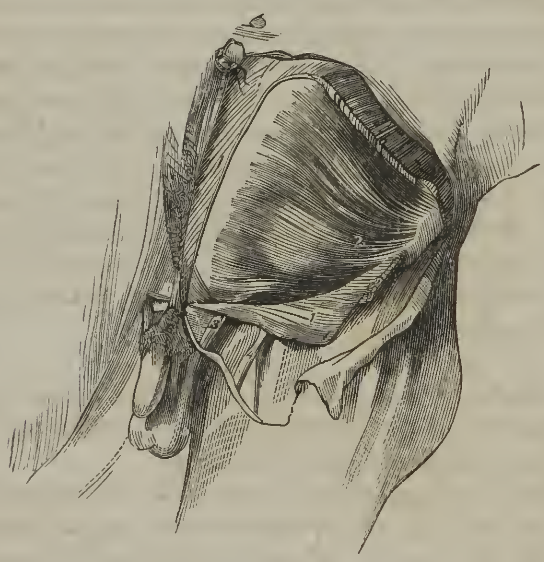
The outlet of the inguinal canal, called the *external abdominal* or *inguinal ring* (Fig. 131, 15), is situated in this tendon almost immediately above the spine of the pubis, and directly in front of the insertion of the conjoined tendon of the internal oblique and transverse muscles. As before stated, it is formed between the fibres of the tendon by a separation commencing some distance above and externally, but is strengthened by a set of curved fibres which pass upward and inward upon the surface of the aponeurosis. The margins of this separation are sometimes called the *columns*, and the intersecting fibres have hence been named the *intercolumnar* fibres;

if carefully examined, they will be found continued from the margins of the ring in a thin tubular sheath upon the spermatic cord, called the *spermatic* or *intercolumnar fascia.* In order to display this fascia to advantage, the handle of the scalpel should be pressed into the ring from behind, in the direction of the scrotum with the superficial fascia, of which it will be seen to be continuous.

If the spermatic fascia is cut from the circumference of the ring, this opening will be found to be nearly oval (as represented in Fig. 131, 15), with its long axis in the direction of the tendinous separation above. Its size in the male adult is from a half to three-quarters of an inch in its longest direction, but it is subject to considerable variety in different individuals.

4. The lower portion of the internal oblique muscle, brought into view by turning aside the preceding aponeurosis, consists of pale

Fig. 132.



The aponeurosis of the external oblique muscle having been divided and turned down, the internal oblique is brought into view with the spermatic cord escaping beneath its lower edge. 1. Aponeurosis of the external oblique. 1′. Lower part of the same turned down. 2. Internal oblique muscle. 3. Spermatic cord. 4. Saphenous vein.

muscular fibres, which originate from the outer third of the crural arch, curve downward and inward, crossing the track of the spermatic cord obliquely from without, and are inserted into the crest of the

pubis directly behind the external ring, by a flattened tendon common to it and the transverse muscle, and usually known as the *conjoined tendon.*

The spermatic cord passes downward and outward beneath the lower curved edge of the internal oblique and transverse muscles, occupying the inguinal canal and traversing the external inguinal ring to reach the scrotum. It has the appearance of a pale fleshy cylindrical mass, and between the thumb and forefinger, it may be felt to consist of several structures, among which may be distinguished, by its firm cord-like feel, the seminal duct or deferential tube on its way from the testicle to the cavity of the pelvis. Of the constituents of the cord, however, only the cremaster muscle should be now examined.

The *cremaster muscle* is the second of the special investments of the cord, the tendon of the external oblique muscle, and the spermatic or intercolumnar fascia, forming the first. It consists of a few fascicles of pale fleshy fibres, which originate from the crural arch immediately below and on the same plane with the lowermost fibres of the internal oblique muscle, and pass down upon the external and anterior surface of the cord. As they descend into the scrotum, the fibres separate and form loops around the testicle and upon the front of the cord, and return to be inserted into the crest of the pubis near the symphysis. The muscle is not equally well developed in all persons; it is very indistinct in some, and in others it consists of numerous bundles nearly as red as those of the internal oblique muscle. Its office is to support the testicle and draw it towards the external ring.*

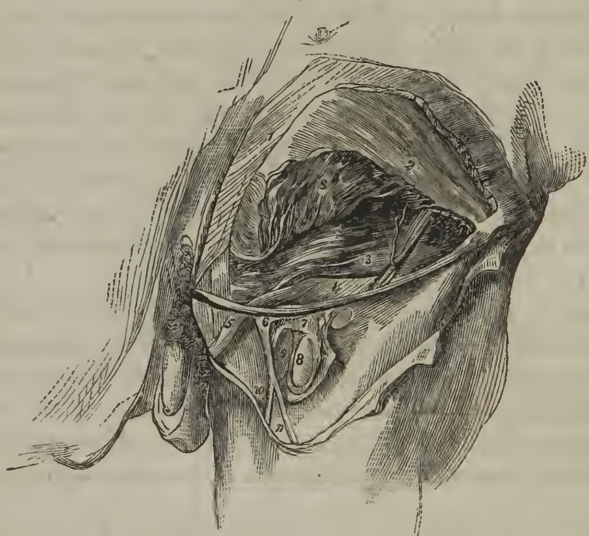
If, before proceeding to an examination of the transverse fascia, the student will look at the posterior surface of the muscular layer just under consideration, he will observe that the lower margin of the transverse is somewhat higher than the margin of the internal oblique muscle, but that like the latter, it arches obliquely across the spermatic cord from Poupart's ligament to the conjoined tendon. In

* The cremaster is usually considered as an appendage to the internal oblique muscle, and is described as originally formed from its lowermost fibres, which are said to be carried down before the testicle, as this organ descends from the cavity of the abdomen into the scrotum. To this explanation, however, there are numerous objections, of which two may be stated here: 1. This origin is opposed to all laws of organic development, being too mechanical and too much a matter of chance. 2. In the buffalo, the muscle is found to surround the testicle before its descent into the scrotum.

some instances, however, this margin is even lower than that of the internal oblique, and the testicle, in descending into the scrotum, has been known to pass through it, thus leaving some of the fibres below the cord.

5. The TRANSVERSE FASCIA (*fascia transversalis*) (Fig. 133, 4), properly so called, is generally a fibrous membrane, but sometimes only a layer of condensed areolar tissue, situated in the lower part of the abdomen behind the transverse muscle. It may be described as extending from the posterior aspect of the crural arch, and the outer margin of the inferior extremity of the straight muscle (rectus abdominis), upward upon the anterior surface of the peritoneum, gradually becoming blended with the common areolar tissue, that connects this latter membrane and the transverse muscle throughout the upper part of the abdomen. At its attachment along the crural arch, it meets with the iliac fascia from the posterior wall of the

Fig. 133.



After the removal of the lower part of the external oblique (with the exception of a small slip including the crural arch), the lower portion of the internal oblique was raised, and thereby the transverse muscle and fascia have been brought into view. The femoral artery and vein are seen to a small extent, the femoral aponeurosis (fascia lata) having been turned aside and the sheath of the vessels laid open. 1. External oblique muscle. 2. Internal oblique. 2′. Part of same turned up. 3. Transverse muscle. Upon the last-named muscle is seen a branch of the circumflex iliac artery with its companion veins; and some ascending tendinous fibres are seen over the conjoined tendon of the two last-named muscles. 4. Transverse fascia. 5. Spermatic cord covered with the tubular or infundibuliform prolongation of the transverse fascia. 6. Upper angle of the iliac part of the femoral aponeurosis. 7. Sheath of the femoral vessels. 8. Femoral artery. 9. Femoral vein. 10. Saphenous vein. 11. A vein joining it.

abdomen, and with the pelvic fascia from behind the anterior wall of the pelvis and below the internal third of the arch, passes out upon the thigh in front of the femoral artery and vein, and forms here a part of a funnel-shaped process, which will be examined in connection with the anatomy of femoral hernia. The outer portion of the transverse fascia which is connected to the external half of the crural arch, is stronger and much more distinctly fibrous than the inner portion, and at the point where these two divisions meet, that is, midway between the spine of the pubis and the superior spine of the ilium, immediately above the crural arch, is the perforation known as the internal abdominal ring.

The INTERNAL INGUINAL OR ABDOMINAL RING is not, as its name would seem to indicate, an abrupt well-defined opening through the transverse fascia; such an opening, for instance, as may be cut in a

Fig. 134.

A portion of the anterior wall of the abdomen and pelvis is here seen from behind, the innominate bone of the left side with the soft parts connected with it having been removed from the rest of the body. 1. Pubic symphysis. 1'. Body of the pubic bone. 2. Irregular surface of the ilium, which has been separated from the sacrum. 3. Spine of the ischium. 4. Tuberosity of the same. 5. Internal obturator muscle. 6. Straight (rectus) muscle of the abdomen covered behind by a thin expansion from the (7) transverse fascia. 8. Iliac fascia covering the iliac muscle. 9. Great psoas muscle cut. 10. External iliac artery. 11. External iliac vein. 12. Epigastric artery and its two accompanying veins. 13. Vessels of the spermatic cord entering the internal abdominal ring. (In this case the ring was unusually small.) 14. Two obturator veins. 15. The fibrous remains of the umbilical artery. The opening upon the right side of the external iliac vein is the internal femoral ring, the entrance to the femoral canal.

piece of paper, but, upon the spermatic cord which occupies it, its margins are prolonged in the form of a delicate sheath, called the

"infundibuliform* process," or *tubular fascia*. This sheath is continued down into the scrotum, often as far as the testicle itself, and may be frequently beautifully demonstrated by inflating it by a blowpipe inserted at the internal ring. This ring is properly the entrance of the inguinal canal, and, by pushing the peritoneum a little back, the spermatic vessels and seminal duct may be seen converging toward it, from the posterior and inferior part of the abdomen.

The internal ring is covered behind by the peritoneum, and protected in front by the lower fibres of the transverse and internal oblique muscles which originate from Poupart's ligament. Its most important relation, however, is with the *epigastric artery*, which branches from the external iliac artery a few lines behind the crural arch, and, in a general way, is directed obliquely upward and inward upon the posterior aspect of the transverse fascia, to the posterior surface of the straight muscle whose sheath it enters. In the first part of its course, it descends a little in order to reach the crural arch, and then ascends obliquely along the inner boundary of the internal inguinal ring, and so near it, that the spermatic cord, as it enters the ring, seems to hook around the vessel. It is, therefore, placed behind the inguinal canal and between the two rings, but much nearer the internal, so that a portion of bowel or other organ pushed into the latter would have the vessel directly upon its inner side; whereas, if the protrusion occurred opposite the external ring, the artery would be some distance to the outer side. This relation should be carefully remembered, for if the artery were divided in an operation, the life of the patient might be endangered.

Besides the epigastric artery, with its two accompanying veins, the seminal duct, and the spermatic vessels, there may also be observed a small fibrous cord upon the external surface of the peritoneum, passing up from the cavity of the pelvis behind the inguinal canal and between the two rings toward the umbilicus. This is the remains of the umbilical artery of the fœtus; and if the peritoneum is laid open and viewed from within, it will be found to form a fold upon the inner face of this membrane and two corresponding fossæ, of which the external is well marked, and being situated opposite the internal ring may act as a predisposing cause to hernia at this point, by detaining a portion of bowel or other organ within its concavity, during violent contraction of the abdominal walls.

Having now separately examined the several layers forming the

* Funnel-shaped.

abdominal parietes in the inguinal region, it will be well to study the relations which they bear, as a whole, to the inguinal canal.

The INGUINAL CANAL is the passage occupied by the spermatic cord between the internal and external rings. It measures in the adult from an inch and a quarter to two inches in length, and is directed obliquely downward, inward, and forward. Its boundaries may be stated as follows: *in front*, it is covered by the tendon of the external oblique muscle, from which, however, it is separated in the outer fourth of its extent by the lowest fibres of the internal oblique and transverse muscles, which originate from the adjacent part of the crural arch; *behind*, it is separated from the peritoneum in its outer three-fourths by the transverse fascia, and at its inner extremity, by the conjoined tendon; *below*, it is closed by the union of the inverted margin of the crural arch with the transverse fascia; *above*, it is crossed obliquely near its outer extremity, by the arched margin of the internal oblique and transverse muscles, and in the remainder of its extent, is closed by the contact of the tendon of the external oblique with the anterior face of the internal oblique.

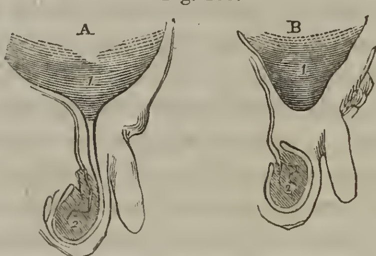
As before mentioned, the inguinal canal is occupied by the *spermatic cord* in the male, and the round ligament of the uterus in the female. The spermatic cord consists essentially of the seminal duct and the spermatic vessels (artery, vein, and lymphatics) and nerves, which, converging from within the abdomen, enter the internal ring, and there become covered, first, by the tubular prolongation of the transverse fascia, then, as they pass the inferior margin of the internal oblique muscle, by the cremaster muscle; and lastly, emerging at the external ring, by the spermatic or inter-columnar fascia. Below the external ring, the cord is placed in front of the body of the pubis beneath the skin and superficial fascia.

Having obtained an accurate knowledge of the anatomy of the inguinal region, the student should take into consideration the occurrence of hernia in this situation; but, as this involves to a certain extent some acquaintance with the history of the formation of the inguinal canal, or, in other words, of the descent of the testicle, a brief outline of this process as it ordinarily occurs, is here introduced.

DESCENT OF THE TESTIS.—The testes or testicles are originally situated within the cavity of the abdomen just below the kidneys, and behind the peritoneum, but covered by it. The vessels belonging to each testis in this situation, are: 1, the small spermatic artery,

which comes from the aorta in the immediate vicinity; 2, the spermatic vein, which is considerably larger than the artery and terminates in the inferior cava or the left renal vein; 3, the seminal duct or deferential tube (vas deferens), which descends from the testicle into the back part of the pelvis behind the peritoneum, and opens into the corresponding ejaculatory duct near the neck of the bladder; 4, the gubernaculum, a small cord-like structure attached by one extremity to the lower back part of the testis, and thence extended through the abdominal walls over the spine of the pubis, at the site of the future external abdominal ring, into the scrotum. It is supposed that by the contraction of this latter structure, which is said to be composed of cellular and muscular fibres,* the testicle is drawn into the scrotum. Be that as it may, during the sixth month of fœtal life, the testis leaves its situation in the lumbar region, descends slowly toward the internal inguinal opening, which at this period is placed directly behind the external, there being no inguinal canal, properly so called, but only a direct perforation, as it were, through the abdominal walls, and finally reaches the scrotum sometime during the eighth or ninth month, or occasionally not until a short time after birth. Accompanying this change of position, there

Fig. 135.



Plans intended to represent a small part of the peritoneum and the vaginal tunic of the testicle. In the first, A, the serous investment of the testis is seen to be an elongation from the peritoneum; while in the second, B, the two membranes are shown distinct one from the other. 1. The peritoneal cavity. 2. The testicle.

is necessarily some change in its connections, of which it is important to have a correct understanding. Thus the spermatic artery and vein, which were before comparatively short and horizontal, become elongated and nearly vertical; and the seminal duct, which previously descended directly into the back part of the pelvis, is now bent over, as it were, describing a curve along the internal lateral wall of this cavity. But the most interesting and singular change is that con-

* Curling.

nected with the peritoneum. As before mentioned, while the testicle is still within the abdomen, the lining membrane of this cavity covers the organ and is reflected from its sides posteriorly, as in the case of the bowels or any other proper abdominal viscus, so that as the testis descends, it necessarily drags this membrane along with it, which, passing through the narrow inguinal openings, assumes somewhat the form of a finger of a glove, communicating above with the main peritoneal cavity, and connected below to the exterior of the testis. This will be better understood by a reference to the accompanying plate, in which this *tubular prolongation* or *vaginal process*, as it is differently called, is well shown. It may be also farther stated that the position of this structure is anterior to the spermatic vessels. But, in the great majority of cases, this condition continues a very short time only; for Nature having no use for a serous membrane along the inguinal canal, obliterates the prolongation, or converts it into common areolar tissue almost down to the testicle itself, leaving the lower extremity of the process as an independent serous sac, known as the *vaginal tunic* of the testicle.

In traversing the inguinal passage, the testicle carries before it: 1st, the transverse fascia; 2d, the cremaster muscle, which, as before stated, is supposed to be only the lower margin of the internal oblique muscle; and, 3d, the intercolumnar or spermatic fascia. All of these structures become spread out upon the spermatic cord, the first as a tubular sheath, the second in the form of pale scattered fibres, and the third as a thin indistinct expansion of areolar tissue, hardly distinguishable from the superficial fascia of the abdomen.

Besides the changes which occur in the vaginal process of the peritoneum, by which this structure is converted into areolar tissue, changes also take place in the abdominal walls in the inguinal region, which are not well understood. Thus, as already stated, at the time of the descent of the testicle, the internal inguinal ring is said to be situated directly opposite the external, over the spine of the pubis, but, in the adult, this opening is found about an inch and a half removed in the direction of the spinous process of the ilium. The common explanation of this is, that in the development of the body, particularly of the bones of the pelvis, the transverse fascia of this region is drawn outward and upward, but why the tendon of the external oblique muscle, in which the external opening is situated, should remain in its original situation, is not clearly comprehended.*

* It should be borne in mind, that if the common explanation is true, the epigastric artery, previous to and at the time of the descent of the testicle, is

Inguinal Hernia.—From the preceding account of the anatomy of the inguinal region, the student will readily understand why protrusion of the abdominal organs is more liable to occur in this situation than elsewhere: for, in the first place, the two most resisting laminæ of the abdominal walls are here perforated for the passage of the testicle, and the accommodation of the spermatic cord; 2dly, the internal oblique and transverse muscles are deficient; and 3dly, in the contraction of the abdominal walls, the pressure of the contained viscera is in a great measure concentrated upon this region.

The most common points of protrusion are the two rings, and the organs most frequently protruded are the small bowel, colon, and omentum. In whichever situation the rupture take place, or whatever organ is involved, the peritoneum lining the wall of the abdomen is always carried before the protruding organ, and constitutes the proper *hernial sac.* In the study of hernia, this fact should be strictly borne in mind. The hernial sac is therefore only a continuation of the peritoneum of the abdomen, lining the interior of the tumor, and varying with the latter, in size and shape, in different cases.

A protrusion, occurring at the internal abdominal ring, is denominated *oblique inguinal hernia*, to distinguish it from the *direct* form which takes place at the external ring. In the former variety, a portion of bowel or other organ enters the internal ring, and, taking the course of the inguinal canal, emerges at the external ring, and thence may descend into the scrotum. It follows the original track of the testicle, and lies, in the majority of cases, in front of the spermatic vessels. The coverings of a hernia of this kind, in which the protruding part has reached the scrotum, consist, therefore, of the same structures that surround the cord beyond the external ring. They are, commencing from without:—

1. The skin, the common integument of the body.
2. The superficial fascia or subcutaneous areolar tissue.
3. The spermatic or inter-columnar fascia.
4. The cremaster muscle, whose fibres may or may not be spread out upon the anterior surface of the tumor.
5. The tubular prolongation of the transverse fascia.
6. The peritoneum or proper hernial sac.

placed upon the inner side of the external ring as well as of the internal, and must also be drawn over to take the position in which it is found in the adult.

In *direct*, or, as it is sometimes called, *ventro-inguinal hernia*, the protruding organ, instead of entering the internal ring, and descending along the inguinal canal, makes a direct passage through the walls of the abdomen opposite the external ring, carrying before it the peritoneum and transverse fascia, and, in many instances also, the conjoined tendon, which protects this ring behind. Very frequently, however, the conjoined tendon is lacerated, in which case, it does not form one of the envelops of the tumor. In this variety of hernia, the spermatic cord is usually pushed to the outer side, but sometimes spreads out in front of the tumor—a fact which should always be borne in mind, when an operation upon the parts becomes necessary. Passing through the external ring, and descending toward the scrotum, the hernia is placed beneath the following structures :—

1. The skin.
2. The superficial fascia.
3. The spermatic or inter-columnar fascia.
4. The conjoined tendon, when this structure is not ruptured.
5. The transverse fascia in an attenuated form.
6. The proper hernial sac.

Such are the nature and position of the structures which lie between the surface and the protruded organ, in the two varieties of inguinal hernia. But the student must not for a moment suppose that, in every case of hernia, these envelops will be found as readily separated and distinguished from each other, as in the natural state of the parts; for, as might be inferred, the irritation or slow inflammation set up by the constant pressure from within, the handling of the tumor by the patient, the injuries which such swellings are constantly receiving, and the treatment employed, produce such changes, that often the most expert anatomist would be puzzled in an attempt to assign to each its particular name. The effect of these changes differs widely in different cases. Sometimes there is thickening, and, at other times, attenuation, and, not unfrequently, complete alteration of some of the tissues, so that, although we may have accurate knowledge of the anatomy of the parts in a healthy condition, this knowledge will be of but little advantage without knowing also these pathological changes.

In operations upon either the oblique or direct variety of inguinal hernia, the position of the epigastric artery should always be previously ascertained. As before stated, this vessel crosses the in-

guinal canal behind, near the internal ring, and in oblique hernia, would therefore be placed directly upon the inner side of the point of protrusion, or, in other words, along the inner side of the neck of the hernial sac. But in the direct form the relation is different; for here, the protrusion taking place opposite the external ring, leaves the artery an inch or more to its outer side. The common direction therefore is, after the hernial sac has been laid open, to divide the stricture with the edge of the knife, turned, in the former case, upward and outward, and in the latter, directly upward, or more safely upward and inward. It is not always possible, however, to distinguish these two varieties, for, in cases of oblique hernia of long standing, the internal ring is found opposite the external, having become dragged down by the long-continued traction of the tumor, and, of course, the epigastric artery is similarly displaced. If the operator, under the supposition that the protrusion was direct, divides the structure upward and inward, he would almost necessarily sever the vessel. The only means of distinguishing these old cases of oblique from direct hernia is, a correct history of each individual case from its commencement; but this being not always possible, and, to prevent any accident in operating where such doubt exists, it is advised to turn the edge of the knife directly upward, thus avoiding the artery in either condition of things.

THE CAVITY OF THE ABDOMEN IN SITU.

The anterior and lateral walls of the abdomen having been dissected, and the cavity laid open by a vertical and a transverse incision, the exposed parts should be examined in a general way before farther procedure.

The cavity of the abdomen is lined by the serous membrane called the peritoneum, which, like all other structures of the same class, is a shut sac, disposed in such a manner as not only to invest the walls of the cavity, but also to give a partial covering to each one of the contained viscera. But as the arrangement of this membrane cannot be well understood, without some acquaintance with the situation and relations of the organs which it covers, these will first claim attention. Commencing above and upon the right side, the *liver* is recognized by its large size, reddish-brown color, firm consistence, and singular shape. It will be seen to occupy nearly the

whole of the right hypochondriac region, extending across the upper part of the epigastric, and oftentimes reaching as far as the left hypochondriac. Its superior or convex surface corresponds to the concavity of the diaphragm, its inferior to the stomach and bowels, and its anterior margin to the lower edge of the thorax. The gall-bladder, the oval-shaped receptacle for the bile, is attached to the under surface of the liver, and somewhat imbedded in its substance. Its situation will be readily discovered by the yellow tinge imparted to the surrounding organs by a *post-mortem* exudation of bile. Deep in the left hypochondrium, and corresponding somewhat in situation to the liver on the opposite side, is the *spleen;* it is of a dark bluish-red color, usually small, and concealed beneath the false ribs, but it is sometimes so much enlarged as to fill almost the whole of this region, extending as low as the left iliac fossa. Between the liver and the spleen, the *stomach* occupies adjacent portions of the left hypochondriac and epigastric regions; it is a large, hollow, conoidal organ, directed from above downward, forward, and to the right side beneath the liver, where its small extremity, called the pylorus, is continuous with the small bowel. The first division of the small intestine, measuring six or eight inches in length, is called the *duodenum.* It commences at the small end of the stomach, ascends for a little way obliquely outward to reach the under surface of the liver, then turns vertically downward, and passes along the contiguous borders of the right hypochondriac and epigastric regions, and again horizontally to the left side, lying in the adjacent parts of the epigastric and umbilical regions, and terminates, to the left of the second lumbar vertebra, in the jejunum. To the left of the vertical portion of the duodenum, and extending transversely across the posterior wall of the abdomen behind the stomach, is the *pancreas;* which, however, cannot be seen at present. The *great omentum* is attached along the lower border of the stomach, and spread out in front of the small intestines, but varies very greatly in size in different individuals. It is a membranous apron formed by a folding of the peritoneum upon itself, and incloses numerous vessels and little masses of fat. The small intestine below the duodenum is divided into the *jejunum* and *ileum.* It lies coiled or folded upon itself in the middle, lateral, and inferior parts of the abdominal cavity, and terminates in the right iliac region, where it opens into the colon, or large bowel, a few inches above its commencement. The *colon* begins by a large blind pouch named the *cæcum*, which

occupies the right iliac fossa. A small, blind, membranous tube, called the *vermiform appendage*, is attached to its extremity, and is generally found coiled up on its inner and posterior surface. From the right iliac region, the colon ascends (ascending colon) through the back part of the right lumbar to the right hypochondriac region, where it turns, and, becoming transverse (transverse colon), traverses the adjacent borders of the epigastric and umbilical regions, and in the left hypochondrium makes a second turn, and descends (descending colon) through the left lumbar and iliac regions into the pelvis, where, on account of its comparatively straight course along the front of the sacrum to the anus, it is called the *rectum*. Just before reaching the pelvis, it forms a remarkable fold, which, from some slight resemblance in shape to the Greek letter ς, is named the sigmoid flexure.

The PERITONEUM is by far the most extensive serous membrane in the body. It is a shut sac in the male, but communicates with the Fallopian tubes of the uterus in the female. It is so disposed within the abdomen that it not only lines the walls or parietes of this cavity, (parietal peritoneum), but is reflected over the contained viscera (visceral peritoneum), giving to many of them a covering almost complete. The external surface of the sac is attached to the surrounding parts by areolar tissue, called from its situation *subperitoneal areolar tissue;* the internal is smooth and polished, always in contact with itself, and kept constantly moist by a thin aqueous or serous exhalation.

The *parietal* portion of the peritoneum is connected to the inner aspect of the anterior and lateral abdominal walls by the subperitoneal areolar tissue, which along the median line is close and dense, but upon each side comparatively open, and subject to a deposition of fat, more particularly in the inguinal regions. In the middle line, above the umbilicus, it is thrown into a fold, called the falciform or suspensory ligament of the liver, inclosing the fibrous remains of the umbilical vein of the fœtus; below this point there is another fold, not so well marked, which leads toward the bladder, and contains the remains of the urachus. Upon the sides of the latter, and descending in a divergent manner from the umbilicus to the lateral walls of the pelvis, are two other slight folds occupied by the vestiges of the umbilical arteries of the fœtus. With these exceptions, the parietal peritoneum is entirely spread out, and if traced in any

direction whatever, will be found uninterruptedly continuous with the visceral portion.

The *visceral* portion of the peritoneum is far more extensive than the parietal, in consequence of its numerous reflections or prolongations upon the several organs; and, although at first sight exceedingly complex in its distribution, may, nevertheless, be traced as a continuous layer from one point to another. Without attempting to follow out these numerous reflections—a feat not always easy, and by no means practically important—the student can readily comprehend how it is that the abdominal viscera, although for the most part invested by this membrane, are *outside* of the cavity of the sac, if he will conceive the abdomen to be empty, but lined with a closed bag made of some very extensible material, and the several viscera subsequently introduced from behind, and pushed forward into their proper places so as to become covered by the posterior layer of the sac. At the same time, he will understand how the vessels pass to and from these organs between the folds of the peritoneum without perforating it.

With these facts in mind, the student should examine the principal reflections, or folds, which perform an essential service in retaining the organs in their places, and supporting the bloodvessels in their course to and from the viscera. The most important are—

1. The LATERAL LIGAMENTS OF THE LIVER.—These are continuations of the peritoneum from the under surface of the diaphragm posteriorly, to which they attach the liver, and are continuous in the median line with the suspensory ligament already mentioned. They will be more particularly described in connection with the anatomy of the liver.

2. The HEPATICO-GASTRIC, or SMALL OMENTUM, is a fold of the serous membrane, consisting of two layers; it extends between the under surface of the liver to the superior curvature of the stomach, and incloses the hepatic, gastric, and splenic arteries.

3. The GASTRO-SPLENIC OMENTUM, also a single fold inclosing numerous vessels, extends from the great end of the stomach to the concave surface of the spleen.

4. The GASTRO-COLIC or GREAT OMENTUM.—This, the largest of the peritoneal folds, lies spread out upon the front of the bowels. It

consists of a double reflection, and has, therefore, four separate layers, of which the two anterior are attached along the greater curvature of the stomach, and the posterior to the transverse colon. Its size varies greatly in different individuals, but generally it reaches half way to the pubis in the form of a broad apron covering the small bowel, and inclosing a few bloodvessels and numerous masses of fat. Its only use seems to be to provide for unusual and sudden distension of the stomach or colon, in which case its layers separate without laceration.

5. The MESOCOLON.—This is a single fold, consisting of two layers of the membrane attaching the large bowel to the posterior wall of the abdomen, but varying in its length in different situations. Thus, opposite the transverse colon (transverse mesocolon) it is remarkably long, and being attached to the posterior wall of the abdomen in a transverse direction, forms a septum between the superior third and the inferior two-thirds of the abdominal cavity. Upon the ascending and descending colon it is very short, and its two layers are here separated by a considerable interval, where the bowel is uncovered and in contact with the posterior abdominal wall in the lumbar regions. Upon the sigmoid flexure it is again quite long, and also upon the first part of the rectum (where it is called the mesorectum), thus allowing these portions considerable freedom of movement.

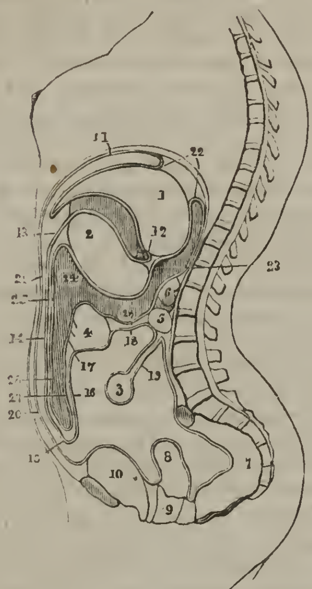
6. The MESENTERY, one of the most interesting of the reflections of the peritoneum, consists of two layers stretched between the small bowel and the posterior abdominal wall; but what is remarkable, its fixed attachment or root, extending from the second lumbar vertebra to the right iliac fossa, is only from four to six inches long, whereas its anterior or floating border incloses from twenty to twenty-five feet of intestine. The breadth of the fold varies from five to eight inches. Between its layers are found the mesenteric bloodvessels, lacteals, and lymphatic glands, together with an abundance of fat.

7. The BROAD LIGAMENTS OF THE UTERUS are also folds of the peritoneum. They extend from the sides of the uterus to the lateral walls of the pelvis, and inclose on each side the round ligament, Fallopian tube, and ovary.

DISSECTION.—If the student is now curious to trace the entire circuit of the peritoneal sac, let him commence where the membrane passes from the

under surface of the diaphragm to the liver (Fig. 136, 1), forming the suspensory and the two lateral ligaments, then following it over the convex sur-

Fig. 136.



Reflections of the peritoneum. 1. Liver. 2. Stomach. 3. Small intestine. 4. Arch of the colon. 5. Duodenum. 6. Pancreas. 7. Rectum. 8. Uterus. 9. Vagina. 10. Bladder. 11. Peritoneum reflected a little farther back, from the diaphragm to the liver, which last it covers above in front and below and forms the anterior lamina of the lesser omentum, 12: it then covers the anterior face of the stomach, and forms at 13 and 14 the anterior layer of the great omentum; at 15, it is reflected upwards to form at 16 the posterior layer of that omentum; at 17, it embraces the colon on its posterior surface and forms the posterior lamina of the mesocolon at 18; it then passes in front of the duodenum, 5, and descends to embrace the small intestine, 3, whence it is reflected upwards so as to give the posterior lamina to the mesentery, 19; it next passes down the posterior parietes of the abdomen, covers the rectum, 7, in front, the uterus, 8, the bladder, 10, and thence ascends to constitute the parietal peritoneum, 20 and 21, lines the diaphragm and terminates above in the lateral ligaments of the liver at 22. If we now trace the peritoneum from the posterior margin of that ligament, 22, we find it coating the posterior face of the stomach, 1, and then separating from that organ to form the posterior lamina of the lesser omentum at 23; it next covers the posterior face of the stomach, 24, and is thence reflected downwards to constitute the posterior layer of the anterior fold of the greater omentum, 25, 26; after which it turns upwards and forms at 27 the anterior layer of the posterior fold of the greater omentum; it then invests the front surface of the colon, 4, and forms at 28 the anterior face of the mesocolon; it thence passes upwards in front of the pancreas, 6, and terminates where we began, at the posterior margin of the lateral ligaments of the liver.

face of this organ to the middle of the inferior surface, he will find it passing off to the superior curvature of the stomach (2), to form the anterior layer of the gastro-hepatic omentum (12). Covering the anterior surface of the stomach, it is continued from the great extremity of this organ to the spleen, having invested which it is brought back again, forming thus the two layers of the gastro-splenic omentum. From the inferior curvature of the stomach it passes downward to form the anterior layer of the great omentum (13, 14),

and, turning back upon itself (15) to form the posterior layer (16), becomes connected to the transverse colon (4), whose lower half it invests (17), and extends back to the spine, constituting the inferior layer of the transverse mesocolon (18). Leaving it here for a moment and introducing the finger beneath the liver at the right side, it will be found to enter a tolerable-sized opening called the *foramen of Winslow*, which is only a constriction of the peritoneal sac, the membrane being here pushed, as it were, around the hepatic artery, and carried downward so as to cover the posterior surface of the stomach, at the greater curvature of which it meets with the anterior layer of the great omentum, goes to form the second layer of this structure (25, 26), and turning back upon itself forms the third layer (27), which, reaching the transverse colon (4) in front of the fourth or posterior layer, covers the superior half of this organ and extends backward to form the superior layer of the transverse mesocolon (28); it then ascends in front of the pancreas (6) to the posterior part of the diaphragm, from which it reaches downward again to the inferior surface of the liver, posteriorly forming thus the posterior layer (22) of the two lateral ligaments. From the under surface of the liver, it passes downward to form the posterior layer of the hepatico-gastric omentum (23). Now, although when thus traced, this seems to be an entirely distinct sac, it is, nevertheless, a part of the main cavity, the communication taking place at the before-mentioned opening.

Continuing now from the point where we stopped, namely, at the inferior layer of the transverse mesocolon, the membrane will be seen to cover the lower surface of the duodenum (5); it then reaches forward toward the small intestine (3), which, having invested, it passes back again, thus forming the two layers of the mesentery (19). From this point on each side, it spreads out upon the posterior wall of the abdomen, and in the lumbar regions binds the ascending and descending colon in its place, leaving a considerable space along the back part of this intestine, in this situation, uncovered. Below it dips into the pelvis, inclosing the rectum (7) by a broad fold, and from the anterior surface of this organ is reflected forward to the inferior back part of the bladder, covering it as far as its fundus, and reaching the anterior wall of the abdomen just above the pubis.* In the female, it stretches from the rectum to the superior back part of the vagina (9), passes up along the posterior surface of the neck and body of the uterus (8), curves over its fundus, and reaches as far downward upon the anterior surface of the organ as the middle of its neck. Thence it is carried forward to the posterior inferior part of the bladder (10), forming thus two blind pouches, one between the rectum and the uterus, and the other between the uterus and the bladder, separated from each other laterally by the broad ligaments of the uterus, which are continuations of the membrane in this direction to cover the round ligaments, Fallopian tubes, and ovaries. From the bladder it extends up the anterior wall of the abdomen to the under surface of the diaphragm.

USES.—Aside from the special use of all serous membranes (namely, to furnish a smooth surface for the movement of the invested organs upon one another and the surrounding parts), the peritoneum forms

* When the bladder is distended, the peritoneum is raised from the anterior wall of the abdomen below to the distance of one or two inches above the pubis, thus rendering it entirely practicable to puncture the organ in this situation without penetrating the peritoneal sac.

the principal means of attachment between the viscera and the walls of the abdomen, by which the former are held in their appropriate places. This is well seen in reference to the liver, which is firmly bound to the diaphragm by the two lateral and suspensory ligaments, or in the small bowel, which is connected by the mesentery to the posterior wall of the abdomen.

VESSELS AND NERVES OF THE ABDOMINAL VISCERA.

DISSECTION.—Having completed the study of the peritoneum, the next step is to expose the principal vessels and nerves of the several viscera, commencing with those of the liver, stomach, and spleen. For this purpose, the anterior border of the liver should be turned up and fastened by hooks close under the margin of the thorax, and the stomach drawn down. If the latter organ is distended with air, this may be removed by a small puncture, or better by forcing it out through the mouth. Then removing the anterior layer of the hepatico-gastric omentum, the short trunk of the *cœliac artery*, dividing into the *hepatic*, *gastric*, and *splenic* arteries, will be brought into view. Surrounding the cœliac artery will also be seen the *solar plexus* of nerves, consisting of the two large flat semilunar masses or ganglia, one on each side, and their numerous intercurrent nerves, consisting of small grayish filaments crossing both above and below the trunk of the vessel.

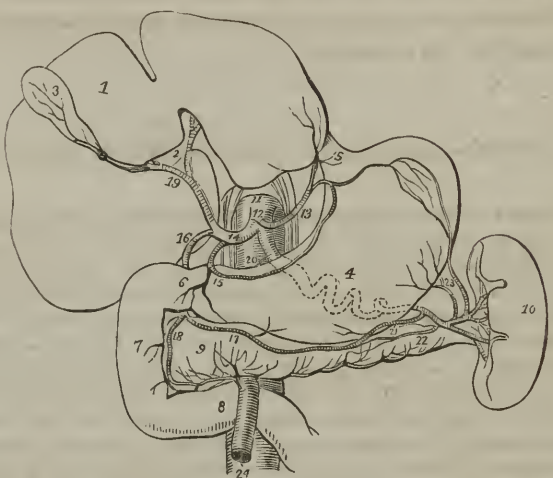
The CŒLIAC ARTERY (*cœliac axis*) (Fig. 137, 12) is the first single trunk given off by the aorta below the diaphragm. It is very large and short, measuring usually not more than a quarter or half an inch in length. It passes directly forward and divides into three branches, the hepatic, gastric, and splenic, of which the last mentioned is the largest. Sometimes it also gives off the arteries of the diaphragm.

The HEPATIC ARTERY (14), the second in point of size of the three branches, passes for a short distance transversely to the right, and then ascends obliquely forward between the two layers of the hepatico-gastric omentum, having the portal vein and common bile duct on its right, and enters the transverse fissure of the liver, where it divides into two branches, one for each lobe.

Branches.—Before entering the substance of the liver the hepatic artery sends off three principal branches: 1. The *pyloric* (15), a small twig which turns off to the left near the pyloric or smaller extremity of the stomach, and running along the superior curvature of this organ, between the two layers of the hepatico-gastric omentum, is distributed to its anterior and posterior surfaces. 2. The *gastro-duodenal* (16), is much larger than the preceding, and originates near

it. It descends behind the commencement of the duodenum to divide into the *pancreatico-duodenal* (18), which is distributed to the duo-

Fig. 137.



The distribution of the branches of the cœliac artery. 1. The liver. 2. Its transverse fissure. 3. The gall-bladder. 4. The stomach. 5. The entrance of the œsophagus. 6. The pylorus. 7. The duodenum, its descending portion. 8. The transverse portion of the duodenum. 9. The pancreas. 10. The spleen. 11. The aorta. 12. The cœliac artery. 13. The gastric artery. 14. The hepatic artery. 15. Its pyloric branch. 16. The gastro-duodenal. 17. The right gastro-epiploic. 18. The pancreatico-duodenal, inosculating with a branch of the superior mesenteric artery. 19. The division of the hepatic artery into its right and left branches; the right giving off the cystic branch. 20. The splenic artery, traced by dotted lines behind the stomach to the spleen. 21. The left gastro-epiploic, inosculating along the great curvature of the stomach with the right gastro-epiploic. 22. The pancreatic branch. 23. The vasa brevia to the great end of the stomach, inosculating with the branches of the gastric artery. 24. The superior mesenteric artery, emerging from between the pancreas and transverse portion of the duodenum.

denum and the adjacent head of the pancreas, and the *hepatico-gastric*, or *right gastro-epiploic* (17), which passes along the inferior curvature of the stomach between the anterior two layers of the great omentum, and is distributed for the most part to the stomach, a few twigs descending into the omentum. 3. The *cystic*, a very small branch, originates from the right of the two terminal divisions of the hepatic within the transverse fissure of the liver, and passing forward, ramifies between the coats of the gall-bladder.

The *gastric* or *coronary artery* (13), the smallest of the three branches of the cœliac, ascends to the left, and having furnished a small branch, the *œsophageal*, to the gastric extremity of the œsophagus, makes an abrupt bend to the right, and running along the upper curvature of the stomach, anastomoses with the pyloric. It also not unfrequently sends a large branch to the liver.

The *splenic artery* (20), the largest and longest of the three divisions of the cœliac, passes off directly to the left, and running in a very tortuous manner along the superior border of the pancreas, in the substance of which it is partly imbedded, reaches the spleen, where it divides into three or four terminal branches, which enter the fissure of the organ at different points. It gives off in its course: 1, several large and small twigs to the pancreas; 2, a considerable branch to the stomach and omentum, and hence called the *splenico-gastric* or *left gastro-epiploic artery* (21), which, passing along the greater curvature of the stomach, between the anterior two layers of the great omentum, anastomoses with the hepatico-gastric or left gastro-epiploic; 3, five or six small twigs called *gastric branches*, or *vasa brevia* (23); these, coming from the terminal divisions of the artery in the fissure of the spleen, run a retrograde course between the layers of the gastro-splenic omentum, to the great or left extremity of the stomach upon which they are distributed.

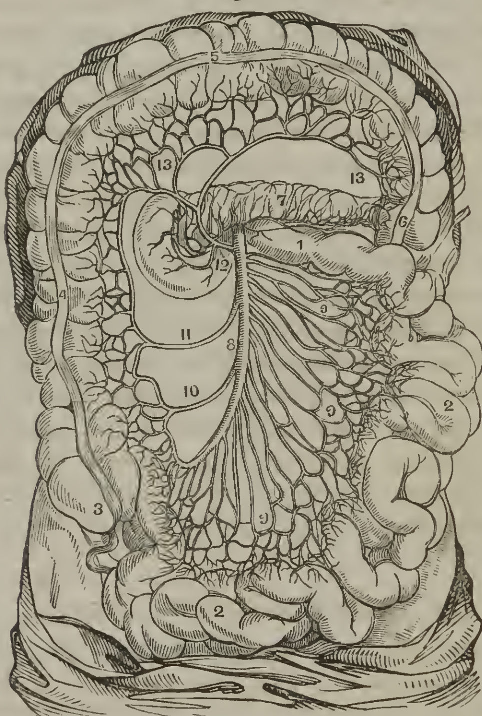
The SOLAR PLEXUS of nerves, also seen in this dissection, is generally looked upon as the great centre or axis of the sympathetic or organic nervous system, just as the brain and spinal cord are considered the centre of the animal system. As before mentioned, it consists of two flattened, grayish-looking, crescentic masses, called the *semilunar ganglia*, each about half the size of an English shilling. The ganglia are situated upon the sides of the cœliac artery, and are connected together by numerous small nervous filaments, crossing in front of the aorta above and below the former vessel. From this plexus most of the abdominal viscera receive their nervous supply. The nervous filaments ramify in connection with the bloodvessels, form numerous smaller plexuses upon the surface of these vessels, and become gradually lost in their external coat.

THE SUPERIOR MESENTERIC ARTERY.

DISSECTION.—Turn the small intestine to the left side, and, feeling for the trunk of the vessel, immediately below the middle of the transverse mesocolon, dissect off the right layer of the mesentery, taking care not to wound the mesenteric veins, which lie for the most part upon the surface of the arteries. If the veins, however, are much in the way, tie the main trunk, and remove the smaller branches entirely. A previous examination of the accompanying plate will materially aid in the performance of the dissection. Some notice should also be taken of the lymphatic glands, called here the *mesenteric glands*, which abound in this situation. The lacteal vessels that penetrate these glands on their way from the intestines to the thoracic duct, lying upon the front of the spinal column, are mostly too small to be dissected without the aid of a magnifying glass.

The superior mesenteric artery (Fig. 138), is the second single branch given off by the aorta below the diaphragm. It originates immediately below and frequently by a common trunk with the cœliac. It is at first placed behind the pancreas, which lies upon the posterior wall of the abdomen at this point, but soon emerging between the inferior margin of this organ and the transverse portion of the duodenum, it descends between the two layers of the mesentery toward the right iliac region, describing a slight curve which is convex toward the small intestines. Its branches are numerous, and many of them are quite large. Thus, in the first part of its course, while behind the pancreas, it furnishes small twigs to the head of this

Fig. 138.



A view of the superior mesenteric artery and its branches, together with some of the associated parts. 1. Duodenum. 2. Jejunum and ilium. 3. Cæcum. 4. Right ascending colon. 5. Transverse arch of the colon. 6. Left descending colon. 7. Pancreas. 8. Superior mesenteric artery. 9, 9, 9. Arteries of the small intestine, twelve or fourteen in number. 10. Ileo-colic artery. 11. Right colic artery (colica dextra). 12. Inferior pancreatico-duodenal artery. 13, 13. Middle colic artery. After Tiedemann.

organ, and to the duodenum (12), and occasionally a large branch to the liver: within the mesentery, it divides into numerous large

branches, distributed to the small intestine, to the cœcum, the ascending and the transverse colon. The *arteries of the small intestine* (vasa intestini tenuis), twelve or fifteen in number, originate from the convexity of the superior mesenteric, and, passing forward, divide and subdivide into still smaller branches, which anastomose freely with each other, and form three or four series of most beautiful arches. These diminish successively in size, but increase in number, until the twigs extend from the last row into the coats of the bowel. The branches going to the large intestine consist of three principal trunks, which come off from the concavity of the curve: they are, the ilio-colic, right colic, and middle colic, the last two often originating by a common trunk. The *ileo-colic* (10), is the proper continuation of the main trunk of the superior mesenteric, and is distributed, as its name indicates, to the commencement of the colon, and the adjacent extremity of the ileum ; it is inclosed in the lower border of the mesentery. The *right colic* (colica dextra) (11) passes nearly transversely to the right, along the posterior wall of the abdomen, behind the peritoneum, and is spent upon the ascending colon in the right lumbar region, anastomosing below with the preceding. The *middle colic* (colica media) (13) originates immediately beneath the margin of the pancreas, and ascending a little to the right, enters the transverse mesocolon, and is distributed principally to the corresponding division of the large bowel. It anastomoses, on the one hand, with the right colic,* and on the other, with the left colic, a branch of the inferior mesenteric.

The SUPERIOR MESENTERIC VEIN is formed by the union of smaller veins with those that accompany the branches of the superior mesenteric artery. It is very large, and situated to the right, and a little in front of the trunk of the artery where it crosses the transverse portion of the duodenum. It unites with the splenic vein behind the pancreas, to form the main trunk of the portal system.

The MESENTERIC GLANDS vary in number from fifty to a hundred or more, and in size, from that of a large grain of wheat to that of an ordinary white bean. They may be readily recognized by their pale fleshy color, oval or rounded figure, and firm consistence. They exist in greatest numbers along the posterior or spinal border of the

* This is the largest arterial anastomosis in the body.

mesentery, and are not often found nearer than within two inches of the intestine. The lacteals pass through these glands before terminating in the thoracic duct.

THE INFERIOR MESENTERIC ARTERY.

DISSECTION.—Turn the small intestine to the right side, and dissect off the peritoneum which covers the posterior wall of the abdomen, between the mesentery and the descending colon.

The inferior mesenteric artery (Fig. 139) is much smaller than the superior. It originates from the aorta, some distance below the latter vessel, descends for a short distance behind the peritoneum, and

Fig. 139.

View of the distribution of the inferior mesenteric artery, its connections with the superior mesenteric, &c. 1. Transverse colon. 2. Descending colon. 3. Sigmoid flexure. 4. Rectum. 5. Small intestine. 6. Pancreas. 7. Superior mesenteric artery. 8. Middle colic of the superior mesenteric. 9. Arteries of the small intestine from the superior mesenteric. 10. Aorta. 11. Left colic. 12. Trunk of the inferior mesenteric artery. 13. Superior hemorrhoidal. 14. Sigmoid or inferior colic artery.

divides into three principal branches, the left colic, the sigmoid, and the superior hemorrhoidal. The *left colic* (colica sinistra), the second

in size of the three branches, passes transversely outward, and is distributed to the descending colon in the left lumbar region; it anastomoses above with the middle colic, a branch of the superior mesenteric.

The *sigmoid*, often a branch of the preceding, passes outward and downward, and is spent upon the sigmoid flexure. The *superior hemorrhoidal*, the largest of the three, descends almost parallel with and along the left side of the aorta into the pelvis, where it enters the mesorectum, and is distributed to the superior part of the corresponding division of the bowel.

The INFERIOR MESENTERIC VEIN is formed by the union of branches corresponding to the divisions of the artery. It ascends along the left side of the aorta, and opens into the splenic vein.

REMOVAL OF THE ABDOMINAL VISCERA.

DISSECTION.—The abdominal organs, having been examined *in situ*, should now be removed entire, and laid aside for more particular study after the posterior wall of the cavity has been dissected. For this purpose, place a ligature upon the œsophagus at its termination, and another upon the middle of the rectum, and divide these two tubes beyond the points where they are tied. Next, dissect the liver from the diaphragm, by dividing the suspensory and lateral ligaments and the inferior cava vein, where it passes through the posterior margin of the organ to perforate the diaphragm. Great care is necessary to avoid cutting through the diaphragm, and thus relaxing it by the admission of air into the cavity of the thorax. This done, draw the organs down, divide the cava vein again about two inches below, then the branches of the cœliac axis, the superior mesenteric artery, the transverse mesocolon, the mesentery, the inferior mesenteric artery, the mesocolon on each side, and the mesorectum, aiding the dissection by means of firm traction from above downward and forward. In cutting through the mesocolon on each side, and the mesentery, pains must be taken not to wound or remove the kidneys and supra-renal capsules, which are situated in the lumbar regions behind the peritoneum.

The viscera having been laid aside for subsequent examination, the peritoneum, cellular tissue, and fat, should be carefully removed from the under surface of the diaphragm and the posterior abdominal walls, in order to display the muscles, vessels, and nerves in this situation.

The removal of the peritoneum from the surface of the diaphragm will require care and perseverance, but if the muscle has not been perforated in the removal of the liver, its beautiful concave surface can be entirely exposed, and the student will be amply repaid for his labor. If, however, the muscle has been relaxed by the admission of air into the thorax, it will be useless to spend time upon it.

In dissecting the posterior wall, the kidneys and supra-renal capsules may be turned to one side or the other, but should not be detached from their connection to the aorta and inferior cava. Compared with the labor neces-

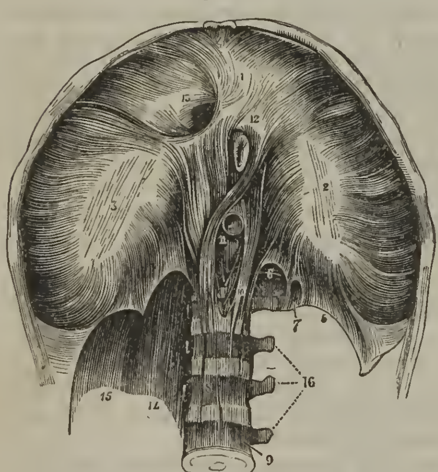
sary to expose the diaphragm, the dissection here is comparatively easy, but may seem somewhat tedious to one who has not a sufficient appreciation of the beautiful in anatomy, to spend an hour or two in cleaning away the fat and other loose tissues, that obscure the view of one of the most interesting parts of the body.

MUSCLES OF THE SUPERIOR AND POSTERIOR ABDOMINAL WALLS.

The superior wall of the abdomen is formed exclusively by the diaphragm; the posterior, on each side of the lumbar vertebræ, by the great and small psoas, the iliac, and the square lumbar muscles, and a part of the diaphragm.

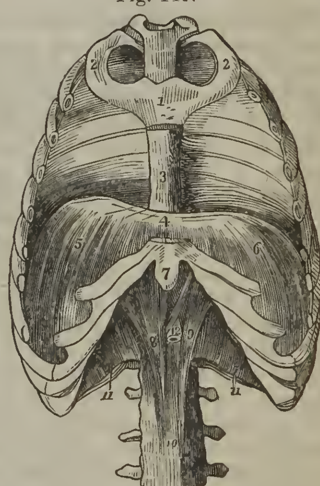
The DIAPHRAGM is situated between the abdominal and thoracic cavities, forming the roof of the former and the floor of the latter. In shape, it bears a remarkable resemblance to an umbelliferous leaf.

Fig. 140.



The diaphragm. 1, 2, 3 Tendinous centre. 5, 6. Arcuate ligaments. 7. Foramen of the lesser splanchnic nerve. 8. Right pillar. 9. Fourth lumbar vertebra. 10. Left pillar. 11. Aortic foramen. 12. Œsophageal foramen. 13. Foramen for the passage of the cava vein. 14. Psoas muscle. 15. Square lumbar muscle. 16. Transverse processes of the lumbar vertebræ.

Fig. 141.



A view of the diaphragm during expiration. 1. The superior extremity of the sternum. 2. The first rib. 3. The dorsal region of the spine. 4. The superior surface of the central tendon of the diaphragm. 5. The right lateral portion of the diaphragm. 6. The left lateral portion. 7. The xiphoid cartilage. 8. The right crus or pillar of the diaphragm. 9. The left pillar. 10. The body of the third lumbar vertebra. 11. The posterior fibres of the diaphragm. 12. The aorta passing between and behind the pillars of the diaphragm.

It consists of a vertical and a horizontal portion, the former representing the stalk, and the latter the expansion of the leaf.

The vertical portion is formed by two parallel muscular bundles, called *pillars* or *crura*, lying upon the anterior aspect of the spine. The right is anterior and larger than the other; it originates by tendinous slips from the bodies and interosseous substance of the lumbar vertebræ, from the first to the fourth inclusive; the left reaches only as low as the third. From the tendinous slips, the fleshy bellies ascend to be inserted into the middle of the horizontal portion behind; but before reaching this point there is an interchange of fibres; a small bundle from each arches over so as to leave below an oblique, elliptical opening for the transmission of the aorta; then diverge, and again approach above the fibres, to surround the circular opening for the œsophagus.

The horizontal portion of the diaphragm is thin and membranous, tendinous at the centre, but fleshy at the circumference; it is transversely elliptical, deeply concave below and convex above, the convexity on the right side reaching as high as the fourth intercostal space, and on the left, as high as the fifth. Its margin is attached to the inner aspect of the lower border of the thorax, as far round on each side as the twelfth rib. From the extremity of this to the transverse process of the first or second lumbar vertebra, and from the latter point to the side of the body of the same bone, it forms two fibrous arches, called the *external* and *internal arcuate ligaments;* the former is much the longer of the two, and crosses the front of the upper part of the square lumbar muscle; the latter covers the upper extremity of the psoas. From the attached margin, or circumference, the fleshy fibres converge in an arched manner toward the central aponeurosis, called the *cordiform tendon*, which is somewhat heart-shaped, with the apex rounded, and presenting toward the ensiform cartilage. This tendon is perforated behind and a little to the right, for the passage of the inferior cava vein.

The openings in the diaphragm are three in number, the aortic, the œsophageal, and the opening for the inferior cava. The *aortic* opening is situated between the vertical pillars and in front of the body of the first lumbar vertebra, a little to the left of the median line. It is oval in an oblique direction, and, besides the aorta, transmits the azygos vein, thoracic duct, and sometimes the left great splanchnic nerve. The *œsophageal* opening, also in the fleshy part of the muscle, is situated above and a little to the left of the aortic;

it is also oval, about three-quarters of an inch in diameter, and is occupied by the œsophagus and the pneumogastric nerves. The *cava* opening occurs in the tendinous portion of the muscle, and is situated to the right of and a little higher than the preceding; it is quadrangular, and gives passage only to the inferior cava vein.

Relations.—The vertical portion of the diaphragm rests upon the front and sides of the bodies of the lumbar vertebræ, from which, at the middle constricted portion, it is separated by the lumbar arteries and veins; its anterior surface is in relation with the aorta and inferior cava, is crossed about its middle by the pancreas, and below by the transverse mesocolon and the horizontal portion of the duodenum, and is inclosed above by the large notch in the posterior margin of the liver. The horizontal portion indigitates at its margins with the transverse muscle. Its superior or convex surface is in contact laterally with the base of the lungs, and in the middle, with the pericardium and the heart. Its inferior surface is in relation on the right side with the right lobe of the liver, the right kidney, and its supra-renal capsule; on the left, with the great extremity of the stomach, the spleen, the pancreas, and the left kidney and its capsule.

Action.—The diaphragm is an active muscle of inspiration; its contraction tends to increase the vertical diameter of the thorax at the expense of the abdomen, whose anterior and lateral walls yield, under ordinary circumstances, in a like proportion. But it is also a powerful aid in difficult defecation, micturition, parturition, &c., in which cases its action, conjoined with that of the anterior and lateral abdominal muscles already described, impels the contained viscera in the direction of the diagonal of the forces, or, in other words, in the direction of the outlets of the body.

Four muscles form the posterior wall of the abdomen upon each side of the lumbar vertebræ. They are: the small and large psoas, the iliac, and the square lumbar muscles.

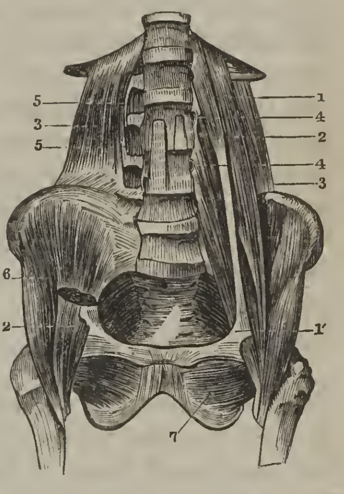
The small psoas muscle (*psoas parvus*) (Fig. 142) is as often wanting as present, and when present, is frequently found upon only one side. It originates from the sides of the bodies of the last dorsal and one or two adjacent lumbar vertebræ, forms a small conical or flattened, fleshy bundle two or three inches in length, and then terminates in a long flat tendon, which, descending a little outward, is inserted into the ilio-pectineal eminence, and into the fascia covering the iliac muscle.

USE.—To make the iliac fascia tense, and to assist in flexing the trunk upon the pelvis, or conversely.

DISSECTION.—The *iliac fascia* covers the iliac and large psoas muscles, and is attached to the inner aspect of the crest of the ilium, the lateral margin of the superior strait of the pelvis, and to the external two-thirds of the crural arch. Over the iliac muscle, it is usually a dense aponeurotic membrane, but upon the surface of the psoas it is thin and delicate, and, if traced downward along the inner border of the latter, will be found to unite with the pelvic fascia to form the posterior half of the sheath of the iliac artery and vein, where these vessels pass beneath the crural arch to the thigh, the anterior half of this sheath being formed by the transverse fascia. As one of the structures entering into the anatomy of femoral hernia, this fascia will hereafter claim particular attention, and for this purpose should be left for the present untouched upon one side of the abdomen.

The LARGE PSOAS MUSCLE (*psoas magnus*) (Fig. 142) is situated in the posterior part of the lumbar and iliac regions, next to the spine, where it forms a large conoidal fleshy mass, known as the *tender loin* in the inferior animals. It originates from the sides of the bodies and roots of the transverse processes of the last dorsal and four upper lumbar vertebræ, and from the corresponding intervertebral cartilages, descends along the lateral margin of the superior strait of the pelvis, and, passing beneath the crural arch, is inserted, by a tendon common with the iliac muscle, into the small trochanter of the femur.

Fig. 142.



1. Small psoas muscle. 1′. Insertion of the tendon of the same into the iliac fascia cut. 2. Great psoas muscle. 3. Square lumbar muscle, partly concealed by the two psoas muscles. 3′. Same of right side entirely exposed. 4, 4. Foramina formed by the grooves upon the bodies of the lumbar vertebræ, and the origins of the great psoas muscle, for the passage of the lumbar arteries and veins. 5, 5. Inter-transverse muscles. 6. Iliac muscle entirely exposed by the removal of 2′, great psoas muscle cut.

RELATIONS.—The superior extremity of the psoas is overlapped by that portion of the margin of the diaphragm called the internal arcuate ligament, and is, therefore, properly within the thorax. Below this point it is in contact with the lower end of the kidney; it is crossed obliquely at its middle by the ureter, and on the left side by the rectum; still lower it is crossed by the seminal tube, and lastly by the crural arch. It rests upon

the square lumbar muscle above, and is here involved with the lumbar plexus of nerves, which is somewhat imbedded in its substance behind. Its inner border overhangs the superior strait of the pelvis, and has resting upon it the primitive and external iliac arteries and veins; its outer border forms, with the iliac muscle, a kind of groove, in which the crural nerve is placed on its way from the lumbar plexus to the thigh. A small nerve, called the genito-crural, perforates the upper part of the muscle, and passes down upon its anterior surface.

Use.—To flex the thigh upon the pelvis, and at the same time to rotate it outwards; or, if the thigh is the fixed point, to flex the trunk upon the femurs, and, if only one muscle acts, to turn it to the opposite side.

The iliac muscle (*iliacus internus*) originates from the surface of the iliac fossa, the transverse process of the fifth lumbar vertebra, the ilio-lumbar ligament, and the lateral surface of the base of the sacrum. From these points the fibres converge, descend forward over the shallow groove between the ilio-pectineal eminence and inferior iliac spine (a large bursa intervening), and over the ilio-femoral articulation, receive a few additional fibres from the capsular ligament, and are inserted, by a tendon common with the psoas, into the small trochanter of the femur. In passing over the margin of the pelvis, a few fleshy fibres, from the inferior spine of the ilium, are added to the outer border of the muscle, and are inserted a little below the trochanter.

Relations.—Each muscle is crossed from within outward by the ilio-scrotal nerve, and covered by the iliac fascia, which separates the right from the cœcum and vermiform appendage, and the left, from the sigmoid flexure of the colon. The *action* of this muscle is similar to that of the preceding.

The square lumbar muscle (*quadratus lumborum*) is situated in the back part of the lumbar region, between the twelfth rib and the crest of the ilium. It is inclosed between two layers of the lumbar fascia, the anterior of which should be dissected off, commencing at the outer border of the muscle and turning it towards the spine. It originates fleshy and tendinous from the ilio-lumbar ligament, from a small part of the adjacent iliac crest, and, by accessory slips, from the transverse processes of the second, third, and fourth lumbar vertebræ. From these points it ascends in the form of a quadrangu-

lar mass, flattened from before backward, and is inserted into the inferior margin of the last rib.

Relations.—Anteriorly, the muscle is crossed above by the external arcuate ligament of the diaphragm, and below this point, by the two musculo-cutaneous nerves; it is in contact with the lower extremity of the kidney. But its most important relation is that with the colon, from which it is separated only by the anterior layer of the lumbar fascia, thus rendering it possible for the surgeon to reach the bowel without opening the peritoneal sac. Posteriorly, it is separated from the erector muscle of the spine by the middle layer of the lumbar fascia.

Use.—To depress the last rib, and thus assist in expiration; to bend the spine to one side or the other, and, both acting at the same time, to assist in supporting the trunk in a vertical position.

Dissection.—Cut the square and psoas muscles from their attachments, and remove the former from the body so as to get a view of the middle layer of the lumbar fascia. Turn down the psoas, and cut it off at the crural arch.

The *lumbar fascia* consists of three layers, of which the two seen in this dissection are thin and delicate, but the third, which covers the posterior surface of the erector muscle of the spine in the lumbar region, is an exceedingly dense and strong aponeurosis. The anterior layer forms the anterior layer of the sheath of the square muscle; it is attached, internally, to the roots of the transverse processes of the lumbar vertebræ, below, to the crest of the ilium, above, to the external accurate margin of the diaphragm. The middle layer is attached to the extremities of the transverse processes of the lumbar vertebræ, above to the twelfth rib, below to the crest of the ilium, and at the outer border of the square muscle, it unites with the anterior layer to give origin to the transverse muscle of the abdomen.

BLOODVESSELS OF THE POSTERIOR ABDOMINAL WALL.

The arteries found in the posterior wall of the abdomen are the abdominal aorta and its branches.

The abdominal aorta is the third division of the primary stem or trunk, from which all the arteries in the body originate, the first

and second divisions being contained within the thorax. It enters the abdomen through the aortic opening between the pillars of the diaphragm, descends in front of the spine a little to the left of the median line, and, having reached the fourth lumbar vertebra, terminates by dividing into the two common or primitive iliac arteries. At its entrance it is quite large, measuring nearly three-quarters of an inch in diameter, but it gradually diminishes in size, so that, at its bifurcation, its diameter rarely exceeds two-fifths or half an inch.

Relations.—Posteriorly, it lies upon the bodies of the vertebræ and the anterior margins of the corresponding inter-vertebral fibro-cartilages, being separated from them only by the anterior common ligament of the spine. Anteriorly, it is crossed by the posterior border of the liver, the pancreas, the horizontal portion of the duodenum, the transverse mesocolon, the left renal vein, and the attached border of the mesentery. On the right side, it is in contact with the right pillar of the diaphragm, the inferior cava vein, the right semilunar ganglion, the commencement of the right axygos vein, and of the thoracic duct; on the left, with the left pillar of the diaphragm, the left semilunar ganglion, and the left common trunk of the sympathetic nerve.

The branches of the aorta are either single or in pairs. The former, commencing above, are: the cœliac, superior mesenteric, inferior mesenteric, and middle sacral; the latter are: the phrenic or diaphragmatic, middle supra-renal, renal or emulgent, spermatic, and lumbar.

The cœliac artery, the largest of all the branches of the abdominal aorta except the common iliac arteries, originates from the anterior aspect of this vessel about half an inch below the anterior margin of the aortic opening of the diaphragm, passes horizontally forward to the distance of a quarter of an inch or sometimes an inch, and divides into three branches, namely, the hepatic, splenic, and gastric.

Relations.—It is in contact, laterally, with the semilunar ganglions; above, with the nerves connecting the ganglions; and inferiorly with similar nervous filaments and the superior border of the pancreas.

The superior mesenteric artery (Fig. 143, 4), the next single and largest branch, commences about half an inch below the cœliac,

descends forward between the pancreas above, and the transverse portion of the duodenum below, enters the mesentery and is distributed to the small intestine, the cæcum, and the ascending and transverse colon.

The INFERIOR MESENTERIC ARTERY (Fig. 143, 5), much smaller than the preceding, arises from the front of the aorta some distance below, passes downward and toward the left side behind the peritoneum, and divides into the left colic, sigmoid, and superior hemorrhoidal arteries, which are distributed to the descending colon and upper part of the rectum.

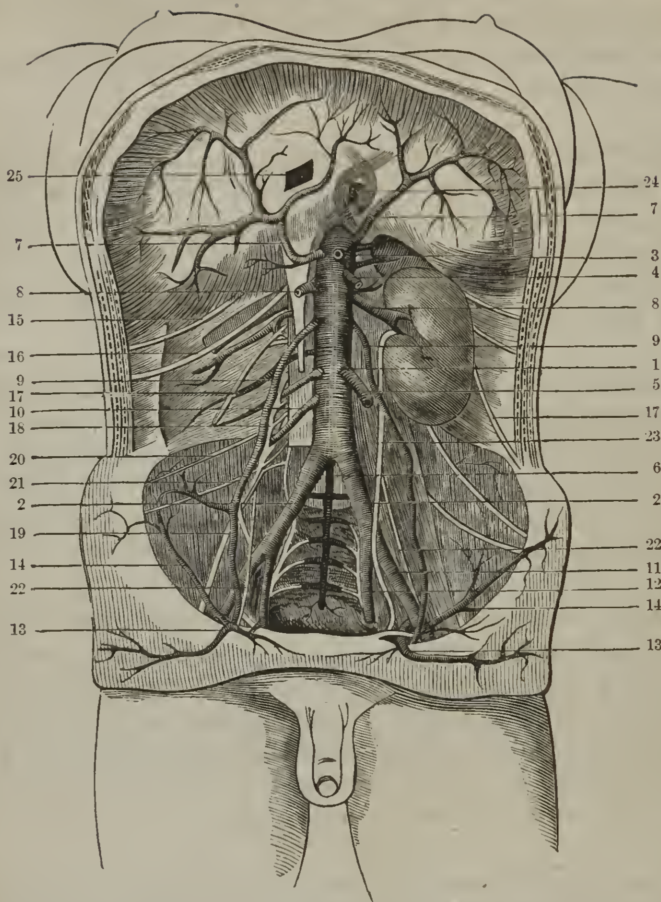
The MIDDLE SACRAL ARTERY (Fig. 143, 6), is a very small branch coming from the posterior aspect of the aorta at its bifurcation. As its name signifies, it rests upon the middle of the sacrum, and is distributed to the adjacent structures. Some of the branches enter the anterior sacral foramina, and emerge at the posterior, to reach the muscular mass in this situation.

The TWO DIAPHRAGMATIC OR PHRENIC ARTERIES (Fig. 143, 7, 7) are generally the first branches given off by the abdominal aorta, from whose lateral aspect they pass upward, and diverge to be distributed to the under surface of the diaphragm, sending also small branches to the supra-renal capsules and the gastric extremity of the œsophagus. They sometimes originate by a single trunk from the front of the aorta, or from the cœliac artery.

The MIDDLE SUPRA-RENAL ARTERIES are very small, and come from the sides of the aorta nearly upon a line with the superior mesenteric, but not infrequently from the cœliac, and are distributed to the supra-renal capsules. They are designated *middle* to distinguish them from the superior, which are branches of the diaphragmatic, and the inferior, which come from the renal arteries.

The RENAL OR EMULGENT ARTERIES (Fig. 143, 8, 8) pass off at right angles from the sides of the aorta opposite the upper lumbar vertebra; the right is a little lower than left, and also longer, from having to cross behind the inferior cava to reach its destination. They are remarkable for their relatively large size, and for the numerous varieties which they present both in number and origin. They are

Fig. 143.



Abdominal portion of the aorta and its branches. 1. Aorta. 2, 2. Primitive iliac arteries. 3. Cœliac artery cut. 4. Superior mesenteric cut. 5. Inferior mesenteric cut. 6. Middle sacral. 7, 7. Diaphragmatic or phrenic arteries. 8, 8. Renal arteries. 9, 9. Spermatic arteries. 10. Lumbar arteries. 11. External iliac. 12. Internal iliac. 13, 13. Epigastric. 14. Circumflex iliac. 15, 16. Musculo-cutaneous nerves. 17, 17. External musculo-cutaneous nerves. 18. Lumbar plexus. 19. Crural nerve. 20, 21. Superior and inferior musculo-cutaneous nerves. 22, 22. Genito-crural nerve. 23. Ureter. 24. Œsophageal opening in the diaphragm. 25. Opening for the ascending cava vein.

not infrequently double, or sometimes even triple, on one or both sides, and arise from different parts of the aorta, or from some of its branches.* They are covered in front by the peritoneum, and generally by the corresponding renal veins, the left lying also behind the

* The author has seen in the same subject four renal arteries on one side, and three on the other, all coming from the aorta.

inferior cava. Before entering the fissure of the kidney, they divide into three or four branches, which are distributed to the different parts of this organ.

The SPERMATIC ARTERIES (Fig. 143, 9, 9) usually come off separately a short distance below the renal, but sometimes by a single short trunk from the front of the aorta, and occasionally one or both from the renal arteries. They are quite small but very long; they descend obliquely outward behind the peritoneum, and accompanied by the spermatic veins, they enter the internal abdominal ring, traverse the inguinal canal, forming one of the constituents of the spermatic cord, and, descending into the scrotum, are distributed principally to the testes. In the female, they take the same direction as far as the ovaries, and are distributed to these organs, to the Fallopian tubes, and to the sides of the uterus.

The LUMBAR ARTERIES (Fig. 143, 10) consist of four or five pairs, which originate from the posterior aspect of the aorta, opposite the body of each lumbar vertebra; curving backward beneath the little tendinous arches that are placed here for their protection, they divide into an anterior and a posterior set of branches, the former distributed to the lateral and anterior walls of the abdomen, and the latter to the muscles of the back and to the spinal cord.

The COMMON OR PRIMITIVE ILIAC ARTERIES (Fig. 143, 2, 2) are the two terminal divisions of the aorta, whose bifurcation is situated in front of the lower margin of the fourth lumbar vertebra. From their origin, they diverge at an acute angle, pass obliquely downward, forward, and outward, lying along the brim of the pelvis and the inner border of the psoas muscles, and, opposite the sacro-iliac symphysis, they divide on each side into the internal and external iliac arteries, the former intended for the parts contained within the pelvis, and the latter for the inferior extremity. They are very large, but short, rarely measuring more than two or two and a half inches in length, straight, but often curved with the concavity presenting upward, and they give off no large branches. They are covered upon their inner and superior aspect by the peritoneum, are both crossed by the ureters, and the left one also by the hemorrhoidal branch of the inferior mesenteric artery. Their relations with the common iliac veins are not precisely the same, for although each vein is situated behind and below its corresponding artery, the left in crossing

the posterior margin of the brim of the pelvis to reach the inferior cava vein, which is situated to the right of the aorta, passes beneath the commencement of the right artery.

The EXTERNAL ILIAC ARTERY (Fig. 143, 11) descends forward and a little outward, upon the inner border of the psoas muscle, to the crural arch, beneath which it passes, and is then called the femoral artery. It is covered superiorly by the peritoneum, and is crossed, on the right side of the body, by the lower extremity of the small intestine, and on the left by the sigmoid flexure of the colon. Beneath the crural arch, the psoas muscle is upon its outer, and the external iliac vein upon its inner side; but, within the abdomen, the vein is beneath or behind the muscle. Its branches are the epigastric and circumflex iliac arteries.

The EPIGASTRIC ARTERY (Fig. 143, 13) arises from the inner aspect of the external iliac, directly beneath or a few lines above the crural arch; it passes for a little way almost horizontally inward and forward, and is then reflected upward and inward, upon the posterior surface of the anterior wall of the abdomen. It lies along the inner side of the internal inguinal ring, and, entering the sheath of the straight (rectus) muscle, is distributed to the surrounding parts, some of its branches reaching nearly as high as the margin of the thorax.

The obturator artery, which is usually a branch of the internal iliac, is sometimes given off by the epigastric; in this case it may descend inward, along the posterior aspect of the crural arch, above the entrance of the crural canal, or may pass directly downward to reach the opening in the obturator membrane.*

The CIRCUMFLEX ILIAC ARTERY (Fig. 143, 14) is somewhat smaller than the preceding. It comes off from the outer side of the external iliac, just beneath the crural arch, and passes upward and outward behind the arch as far as the superior spine of the ilium. Here it divides into two branches, one of which ascends in the substance of the anterior abdominal wall, and the other winds along the iliac crest between the external oblique and transverse muscles, and anastomoses with the ilio-lumbar, a branch of the internal iliac.

* The relations which this vessel bears to crural hernia will be mentioned hereafter.

VEINS.—The veins found upon the posterior wall of the abdomen for the most part accompany corresponding arteries, and open into the inferior cava vein, which forms the main channel through which all the venous blood from the inferior extremities and the sub-diaphragmatic division of the trunk is returned to the heart. The veins from the digestive organs, however—the stomach, small and large intestines, spleen, and pancreas—unite to form a common trunk called the PORTAL VEIN, which ramifies like an artery through the substance of the liver; but the blood which it conveys to this organ ultimately reaches the inferior cava by the hepatic veins, as will be hereafter described.

The INFERIOR OR ASCENDING CAVA VEIN, the largest venous trunk in the body, commences opposite the fourth lumbar vertebra, by the union of the two common iliac veins. It ascends in front of the spine along the right side of the aorta, and, therefore, a little to the right of the median line, and, having traversed the quadrangular opening in the tendinous portion of the diaphragm, opens almost immediately into the right auricle of the heart. In its course, it receives the common iliac veins, the middle sacral, lumbar, spermatic, renal, supra-renal, hepatic, and diaphragmatic veins.

The EXTERNAL ILIAC VEIN is the continuation of the femoral vein within the abdomen. It is situated, while under the crural arch, close to the inner side of the artery, but, passing backward to join the internal iliac, it gradually gains the under surface of the artery, resting upon the inner border of the psoas muscle. Near the crural arch it receives the epigastric and circumflex iliac veins, which accompany the arteries of the same name. Between the inner border of the external iliac vein, where it is continuous with the femoral, and with the crescentic edge of Gimbernat's ligament, and beneath the internal extremity of the crural arch, is the transversely-oval opening known as the internal crural ring, or the entrance to the crural canal, to be hereafter described in connection with crural hernia.

The INTERNAL ILIAC VEIN accompanies the internal iliac artery, and will be seen in the dissection of the contents of the pelvis.

The COMMON ILIAC VEIN results from the union of the external and internal iliacs, and commences, therefore, opposite the sacro-iliac symphysis; thence it ascends backward and inward, to unite with its

fellow of the opposite side at the commencement of the inferior cava. The right vein crosses the corresponding artery obliquely behind to reach its outer aspect; the left, larger than the right, is at first beneath and parallel to its corresponding artery, but subsequently it crosses the front of the last lumbar vertebra, beneath the right artery at its commencement.

The MIDDLE SACRAL VEIN is very small; it corresponds to the artery of the same name, and opens into the commencement of the cava vein behind.

The LUMBAR VEINS, three or four on each side, receive the blood from the muscles of the loins, and from the lower part of the spinal cord, and, winding around the lumbar vertebræ in company with the lumbar arteries, open into the adjacent back part of the cava.

The SPERMATIC VEINS, one on each side and quite small, pass obliquely upward from the internal inguinal ring alongside of the spermatic arteries, and open, the right into the inferior cava, and the left into the left renal vein.

The RENAL OF EMULGENT VEINS are generally single on each side and very large. They pass transversely from the fissure of the kidney into the adjacent part of the cava. The left is the longer of the two; it receives the left spermatic vein at a right angle, and crosses the front of the aorta.

The SUPRA-RENAL OF CAPSULAR VEINS, one on each side, are very small, and, as their name indicates, come from the supra-renal capsules. The right terminates in the cava, and the left in the renal vein.

The HEPATIC VEINS will be seen in the examination of the liver, from the notch of whose posterior border they emerge, and terminate immediately in the inferior cava.

The DIAPHRAGMATIC OF PHRENIC VEINS, two on each side, accompany the diaphragmatic arteries, and generally terminate in the cava just at its entrance into the tendinous opening of the diaphragm, but they sometimes open into the hepatic veins.

The AZYGOS VEINS, two in number, belong more properly to the anatomy of the thorax, but their commencement in the abdomen may be seen in this dissection.

The *right* or *greater azygos* commences upon the right side of the bodies of the lumbar vertebræ, by communications with the inferior cava and the lumbar veins. It ascends in front of the roots of the transverse processes, and, entering the thorax through the aortic opening of the diaphragm, becomes much enlarged by the numerous intercostal veins which empty into it, and terminates, finally, in the superior cava vein.

The *left* or *semi-azygos*, much smaller than the preceding, begins upon the left side of the lumbar vertebræ. It receives branches from the left lumbar veins, and sometimes a small communicating branch from the left renal vein, enters the thorax beneath the internal arcuate margin of the diaphragm or through the aortic opening, and finally terminates by crossing the front of the spine transversely to reach the right azygos.

The THORACIC DUCT, the main trunk of the lymphatic system of vessels, commences in the abdomen upon the front of the upper lumbar vertebra, behind and a little to the right of the aorta. Here the vessel is somewhat dilated into an elongated sac about the size of a small goose-quill, called the *receptacle of the chyle* (receptaculum chyli), which receives the lacteals of the mesentery, and, becoming narrow as its ascends, enters the thorax through the aortic opening of the diaphragm, and continuing its course along the front of the spine, terminates eventually in the left subclavian vein.*

The small size of the duct and the extreme thinness of its walls render it often difficult to find, unless it has been previously filled with solid injection.

NERVES OF THE ABDOMEN.

The nerves of the abdomen belong both to the organic and cerebro-spinal systems.

The ORGANIC NERVES* are either branches of the solar plexus or of the two main trunks of the sympathetic nerve.

* If the student is at work upon his first subject, I would not advise him to

The SOLAR PLEXUS, as before mentioned, consists of two flattened, irregularly triangular, grayish bodies, about the size of small Lima beans, and called the *semilunar ganglia.* They are situated upon the sides of the cœliac artery, and connected by numerous, small, nervous filaments that cross in front of the aorta above and below the cœliac artery. Each semilunar ganglion receives from the thorax the great splanchnic nerve; this, as will be seen hereafter, is but a branch, as it were, of the sympathetic nerve, and gives off the numerous filaments which go to form other but smaller plexuses, destined for the different abdominal viscera. The most important of these secondary plexuses are: 1, the *diaphragmatic*, a network of filaments accompanying the arteries of the same name; 2, the *supra-renal*, consisting of a minute ganglion and a few delicate offsets from the solar plexus, which enter the upper and inner part of the capsule; 3, the *renal*, formed by numerous branches from the solar plexus and several small ganglia, accompanies the renal artery into the substance of the kidney;* 4, the *spermatic*, very small, and formed principally by branches of the renal plexus, accompanies the spermatic artery to its distribution; 5, the *superior mesenteric*, one of the largest of the secondary plexuses, consists of a great number of filaments, including one from the pneumogastric nerve, which accompany the artery and its branches to their ultimate ramifications in the mucous membrane of the bowel; 6, the *aortic*, considered by Quain as a prolongation of the solar plexus, consists of interlaced filaments occupying the surface of the aorta between the superior and inferior mesenteric arteries, and gives offsets to the spermatic, inferior mesenteric, and hypogastric plexuses; 7, the *inferior mesenteric* surrounds the inferior mesenteric artery, and accompanies its branches to the large bowel; 8, the *cœliac*, properly a part of the solar plexus, surrounds the cœliac artery, and divides with this vessel into the hepatic, coronary, and splenic plexuses, which proceed to the several organs supplied by the branches of this artery.

Each of the TWO SYMPATHETIC NERVES consists of a series of connected ganglia, situated upon the sides of the bodies of the vertebræ, and reaching from the base of the cranium to the coccyx. These ganglia are generally small, fusiform, and of a bluish-gray or pearl color,

attempt to dissect out these nerves, for, even with the advantage of a previous knowledge of their situation, it is a very difficult undertaking.

* This plexus receives the smaller splanchnic nerve from the thorax.

and may be found in the abdomen upon the sides of the bodies of the lumbar vertebræ, in front of the roots of the transverse processes. The ganglia are connected by a small gray nervous filament, extending from the inferior extremity of each to the superior of the one below, so that the ganglia appear to be only enlargements or swellings upon a continuous nervous trunk; whereas, they are properly independent centres from which the connecting filaments are given off.

The branches of the sympathetic nerves originate from the ganglia, and are arranged into two general divisions, an anterior and a posterior; the former follows the course of the branches of the aorta, to enter the solar plexus of the several secondary plexuses formed from it; the latter turns backward to join the spinal nerves as they emerge from the spinal canal.

Spinal Nerves.—The principal spinal nerves seen in this dissection, are branches of the anterior divisions of the four upper lumbar nerves, which, emerging at their corresponding inter-vertebral foramina, enter the substance of the large psoas muscle. Here, by an interchange of fibres, they constitute the *lumbar plexus* (Fig. 143, 18), which receives also a branch from the last dorsal nerve. The branches of the lumbar plexus are the following:—

1. The superior musculo-cutaneous, or ilio-scrotal nerve (Fig. 143, 20), originates from the upper part of the lumbar plexus, and is formed exclusively from the first lumbar nerve. It passes outward and downward across the superior part of the square lumbar muscle, perforates the transverse muscle, and running forward along the crest of the ilium between the transverse and internal-oblique muscles, divides into two branches, of which the *superior* and smaller is distributed to the anterior wall of the abdomen, and the *anterior* or *scrotal* branch, descending along the crural arch, accompanies the spermatic cord into the scrotum.

2. The inferior musculo-cutaneous nerve (Fig. 143, 21) originates just below the preceding, and is formed from divisions of the first and second lumbar nerves. It crosses the square lumbar and iliac muscles in the direction of the superior spinous process of the ilium, and is distributed to the skin and muscles in this situation, some of its cutaneous filaments reaching as far as the pubes.

3. The EXTERNAL MUSCULO-CUTANEOUS NERVE (Fig. 143, 17), a branch of the second lumbar, pierces the posterior part of the large psoas muscle, follows its external border for a little way, is then directed across the iliac muscle, passes beneath the external extremity of the crural arch, and divides into an anterior and a posterior branch, which are distributed to the skin upon the front and posterior aspect of the thigh.

4. The GENITO-CRURAL NERVE (Fig. 143, 22) is a small filament from the second lumbar nerve. It perforates the upper part of the large psoas muscle from behind forward, and passing down upon its anterior surface as far as the crural arch, divides into a scrotal and a crural branch; the former emerges at the external inguinal ring, and the latter beneath the crural arch, to be distributed to the skin upon the inner side of the thigh. While upon the surface of the psoas muscle, this nerve is in close relation with the ureter, which is supposed to account for the pain and retraction of the testicle, in the passage of calculi from the kidney to the bladder.

5. The CRURAL NERVE (Fig. 143, 19). This is the largest of the branches of the lumbar plexus, and is formed from divisions of the second, third, and fourth lumbar nerves. It descends at first behind the psoas muscle, and then between its outer border and the iliac muscle, as far as the crural arch, beneath which it goes out upon the thigh.

6. The OBTURATOR NERVE, the most inferior of the branches of the lumbar plexus, originates from the third and fourth lumbar nerves, passes along the lateral wall of the pelvis to the superior angle of the obturator foramen, through which it reaches the muscles upon the inner part of the thigh. It is accompanied by the obturator artery and vein.

The *fifth lumbar*, or the *lumbo-sacral nerve*, does not properly form a part of the lumbar plexus. It emerges from the fifth lumbar inter-vertebral foramen, receives a branch from the fourth lumbar nerve, and descends into the pelvis over the sacro-iliac symphysis, lying close to the bones, to join the sacral plexus.

THE ABDOMINAL VISCERA.

Dissection.—Having completed the examination of the posterior wall of the abdomen, the student should proceed to the study of the viscera. These should be well washed externally without separating their attachments, the stomach and intestines slightly inflated, and the whole placed upon the table as nearly in their natural position as possible.

The alimentary canal, the centre of the digestive apparatus, is a long membranous tube, of different size and structure in different situations, and extending from the mouth to the anus. It consists of six principal parts, of which three are situated above, and three below the diaphragm. The parts above the diaphragm are the mouth, pharynx, and œsophagus, which will be seen in the dissection of the regions in which they are placed. The abdominal division consists of

1. The stomach.
2. The small intestine.
3. The large intestine.

The Stomach.—The stomach is situated in the upper part of the abdomen, occupying nearly the whole of the left hypochondriac and a large part of the epigastric region, and reaching sometimes into the right hypochondriac. It is held in its place by the œsophagus and duodenum, with which it is continuous, by the hepatico-gastric and the gastro-colic omentum, by its bloodvessels, and by the pressure of the surrounding parts.

Fig. 144.

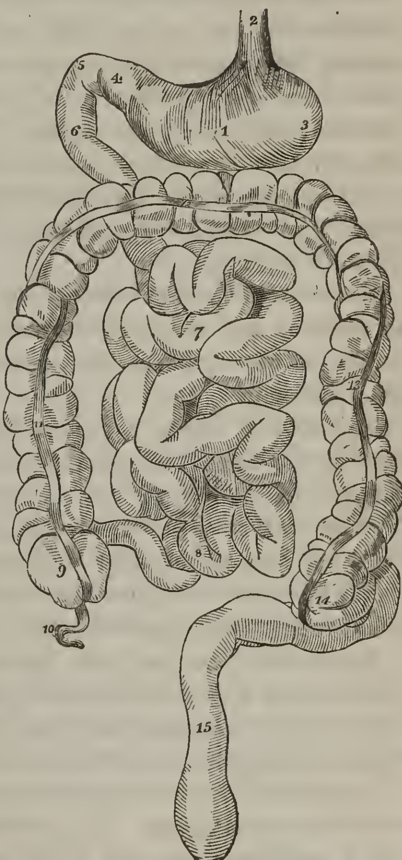


Diagram of the stomach and intestines, to show their course. 1. Stomach. 2. Œsophagus. 3. Left, and 4, Right end of stomach. 5, 6. Duodenum. 7. Convolutions of jejunum. 8. Those of ilium. 9. Cæcum. 10. Vermiform appendage. 11. Ascending, 12, Transverse, and 13, Descending colon. 14. Commencement of sigmoid flexure. 15. Rectum.

It is irregularly conoidal in shape, slightly flattened from before backward, and bent upon itself with the concavity presenting upward and to the right. When in a state of moderate distension, it is directed from above downward, forward, and toward the right side; but when distended to its utmost, it lies almost transversely across the left hypochondriac and epigastric regions, and encroaches upon the umbilical. When entirely empty, it is nearly vertical, and contained only within the left hypochondriac region. These facts should be borne in mind in the diagnosis of wounds penetrating the abdomen.

In the human subject, the stomach is single; and, aside from its variations in size in the same individual under different circumstances, differs in actual capacity in different individuals. Sometimes it measures only a little more in diameter than the small intestine; and again, it is capable of containing one or two gallons. This difference depends in a great measure upon the different habits of eating; the organ being usually small in persons accustomed to four or five meals a day, and large in those who eat but once during the same time.

For convenience of description, the stomach is divided into an anterior and a posterior surface, a superior and an inferior border or curvature, a base or large extremity, and an apex or small extremity.

The *anterior surface* is convex, the convexity depending upon the state of the organ. It presents directly forward when the cavity is only partly full, and forward and upward when largely distended. It is in contact with the diaphragm, which separates it from the heart and base of the lungs, with the under surface of the left lobe of the liver, and to a greater or less extent with the anterior abdominal wall in the epigastric region.

The *posterior surface* looks backward and a little downward; it is in relation with the posterior wall of the abdomen and anterior surface of the pancreas, and, when the organ is distended, with the supra-renal capsule and kidney, and the transverse mesocolon.

The *base* or *large extremity* is convex, and situated deep within the left hypochondrium. It presents upward and a little outward, and is in relation with the diaphragm, which separates it from the base of the right lung, and with the concave surface of the spleen, to which it is attached by the gastro-splenic omentum.

The *small* or *pyloric extremity* representing the apex of the cone, presents upward, outward, and a little backward, and is continuous

with the duodenum. Owing to the oblique direction of the organ, this extremity is upon a plane somewhat anterior to the base. Immediately to the left of the apex, the organ presents a slight swelling, which is analogous to the second stomach of some of the inferior animals.

The superior or concave border (lesser curvature) of the stomach measures from four to five inches in length. It is directed upward and backward, embracing the Spigelian lobe of the liver, and the structures upon the anterior surface of the spine. It is attached to the transverse fissure of the liver by the hepatico-gastric omentum, and has resting upon it the pyloric and gastric arteries and their accompanying veins. At the junction of the superior border and the left extremity, the stomach makes an obtuse angle with the œsophagus. The opening between them is called the *œsophageal* or *cardiac orifice*, in distinction from the *pyloric orifice*, which communicates with the duodenum.

The inferior or convex border (greater curvature) is much longer than the superior, and is in relation in the greater part of its extent with the transverse colon, to which it is attached by the gastro-colic or great omentum. The right and left gastro-epiploic arteries and veins pass along this border.

VESSELS.—The *arteries* of the stomach are numerous, and comparatively large: they are the gastric or coronary, pyloric branch of the hepatic, hepatico-gastric or right gastro-epiploic, splenico-gastric or left gastro-epiploic, and small recurrent branches (vasa brevia) of the splenic artery. The *veins* for the most part accompany the arteries, and terminate eventually in the portal vein. The lymphatics or absorbent vessels are very numerous, and enter the lymphatic glands situated along the superior and inferior borders of the organ.

The nerves are branches of the solar plexus and of the pneumogastric nerves, which enter the abdomen with the œsophagus. The *structure* of the stomach is in many respects similar to that of the small and large intestines, and will be hereafter described.

THE SMALL INTESTINE.—The small intestine, comprising all that part of the alimentary canal between the stomach and the large bowel, is situated for the most part in the umbilical and hypogastric regions, and extends also into the lumbar and iliac. It has the form of a long cylindrical tube bent many times upon itself, and present-

ing a coiled or convoluted appearance. Its average length is from eighteen to twenty feet.* Its diameter is largest at its commencement or duodenal extremity, and gradually diminishes to its termination or colic extremity. For description, it is considered in three divisions, called respectively the duodenum, jejunum, and ileum.

The DUODENUM† (Fig. 144), the first and largest portion, measures from eight to nine inches in length, and extends from the pyloric extremity of the stomach to the commencement of the jejunum,

Fig. 145.

In this figure, which is altered from Tiedemann, the liver and stomach are turned up, to show the duodenum, the pancreas, and the spleen. *l*. The under surface of the liver. *g*. Gall-bladder. *f*. The common bile duct, formed by the union of a duct from the gall-bladder, called the cystic duct, and of the hepatic duct coming from the liver. *o*. The cardiac end of the stomach, where the œsophagus enters. *s*. Under surface of the stomach. *p*. Pyloric end of the stomach. *d*. Duodenum. *h*. Head of pancreas; *t*. tail; and *i*, body of that gland. The substance of the pancreas is removed in front, to show the pancreatic duct (*e*) and its branches. *r*. The spleen. *v*. The hilus, at which the bloodvessels enter. *c*. Pillars of diaphragm. *n*. Superior mesenteric artery. *a*. Aorta.

below the transverse mesocolon on the left side of the second lumbar vertebra. From its commencement it ascends towards the right and a little backward, between the two layers of the hepatico-gastric omentum to the under surface of the liver, then makes a sudden bend, and descends almost vertically, and finally turns transversely across the front of the spine to terminate in the jejunum. The *ascending* portion, which is the only part seen when the abdomen is

* In a subject of somewhat less than medium height, I found the small intestine not to exceed eleven or twelve feet.

† From *duodenus*, because it generally measures about twelve fingers' breadth in length.

first opened, is about two inches long, and lies in front, and a little to the left of the neck of the gall-bladder and hepatic vessels. The second or *vertical* portion, is from two to three inches long, forms an acute angle with the first, and is situated in the adjacent parts of the epigastric and left hypochondriac regions, where it is permanently fixed by the peritoneum, which covers only its anterior surface. It is in relation, behind, with the inner margin of the right kidney, ascending cava vein, and common bile duct; externally, with the superior extremity of the ascending colon, and internally, with the head of the pancreas, and with the common bile duct, which, in connection with the pancreatic duct, perforates its lower part, as will be seen hereafter. The third or *transverse* portion, three or four inches in length, forms a right angle with the preceding, and is firmly inclosed between the two layers of the transverse mesocolon. It is in relation, behind, with the aorta and inferior cava, and in front, with the superior mesenteric artery and vein, which cross it at a right angle.

The JEJUNUM* and ILEUM† constitute the remaining portions of the small intestine. To the former are assigned the upper two-fifths, and to the latter the lower three-fifths. The distinction is wholly arbitrary, as no natural mark of limitation exists. They occupy the umbilical and hypogastric regions, extending also into the lumbar regions, in front of the ascending and descending colon, and to a greater or less extent into the cavity of the pelvis, between the rectum and bladder. The two together measure from fifteen to twenty feet in length. Being many times folded or coiled, their direction is very tortuous, but, in a general way, oblique from the left side of the second lumbar vertebra toward the right iliac fossa. Their size is less than that of any other part of the alimentary canal except the œsophagus, and gradually diminishes from above downward.

The convolutions or folds of the jejunum and ileum are attached to the posterior wall of the abdomen by the mesentery, but, owing to the length of this structure, are by no means constant in their number or situation. Each one, however, may be considered as having a free convex border presenting, generally, transversely toward the anterior wall of the abdomen, but often separated from it

* From *jejunus*, empty—because generally found in this condition.

† From ειλεω, to turn or coil.

by the gastro-colic omentum, and a posterior or concave border, continuous by its peritoneal coat with the anterior margin of the mesentery. The peculiar form of the mesentery and of its attachments has been already alluded to (p. 294). The last coil of the ileum differs from most of the others in forming a curve with its concavity directed upward, the right extremity of the curve passing upward and toward the right, to terminate at an obtuse angle upon the left wall of the colon.

VESSELS.—The *arteries* of the small intestine, with the exception of the duodenal branch of the hepatic, are branches of the superior mesenteric, which, with its accompanying vein, has been already seen. The disposition of these vessels and also of the lacteals, with which the duodenum and jejunum are so numerously supplied, will be noticed in connection with the structure of the alimentary tube.

The nerves are branches of the mesenteric plexus, and accompany the arteries to their minute ramifications.

THE LARGE INTESTINE (Fig. 144).—The large bowel, the third division of the abdominal portion of the digestive canal, commences in the right iliac region a few inches below the termination of the ileum, and ascends through the back part of the right lumbar to the right hypochondriac region; here it makes an abrupt turn and crosses the upper part of the abdomen, through the adjacent parts of the epigastric and umbilical regions to reach the left hypochondrium. At this point it makes a second bend through the back part of the left lumbar and iliac regions, forming here a large fold called the *sigmoid flexure*, enters the pelvis, and, continuing its descent along the anterior surface of the sacrum and coccyx, terminates at the anus. Although cylindrical, it is not uniformly so, but presents numerous enlargements or dilations separated by transverse constrictions, and arranged into three rows separated by the same number of longitudinal bands. Its length varies from five to six feet. Its size, also subject to considerable variety, is always greater than that of any other division of the alimentary canal except the stomach, but gradually diminishes from its commencement to its termination; a considerable dilatation, however, exists a few inches above the anus. Connected to its external surface are nearly always found, except in emaciated individuals, numerous little pedunculated masses of fat, which are inclosed by the peritoneum and are called *epiploic appendages*.

The large intestine is divided, by anatomists, into the cæcum, with its vermiform appendage, the colon, including the sigmoid flexure, and the rectum.

The CÆCUM, the first and largest of the three divisions, comprises all that part of the large bowel situated below the entrance of the ileum. As its name indicates, it is a *blind* pouch or sac, and measures from two to four inches in length, and as many in breadth. It occupies the right iliac fossa, resting upon the iliac muscle, from which it is separated by the iliac fascia, and is directed obliquely from below upward and outward, forming an obtuse angle with the colon. It is held in its position by the peritoneum, which covers only its anterior and lateral surfaces, and is in relation, in front, with the anterior abdominal wall, internally with the lower end of the ileum, and posteriorly with the iliac fascia. Its great size, which sometimes nearly equals that of the stomach, is no doubt partly due to its depending position and consequent liability to accumulations of fecal matter, which often give rise to serious constitutional disturbance.

Connected to the lower internal wall of the cæcum, and communicating with its cavity, is the *vermiform process* or *appendage*, a blind membranous tube about the size of a large goose-quill, and from four to five inches in length. It is generally found coiled up in a fold of the peritoneum upon the surface of the iliac fascia, or upon the inner aspect of the cæcum.

The COLON consists of ascending, transverse, and descending portions. The *ascending* or right colon extends from the cæcum to the transverse colon, traversing the back part of the right lumbar region, and forming a curve with its concavity presenting forward. It is held in its position by the peritoneum, which covers only its lateral and anterior surfaces, and is in relation anteriorly with the small intestines, and posteriorly, with the square lumbar muscle and right kidney, to both of which it is connected by areolar tissue, the peritoneal investment being here deficient.

The *transverse* colon, or, as it is sometimes called, the *arch* of the colon, is intermediate in size and position between the ascending and descending divisions. In its course across the abdomen it forms a curve whose convexity presents forward, and gives attachment to the gastro-colic omentum, and is in contact with the anterior wall of the abdomen, along the adjacent borders of the epigastric and umbilical regions. Its posterior or concave surface is in relation with the

transverse portion of the duodenum, and is attached to the posterior abdominal wall by a very broad mesocolon, which forms a septum between the upper third and lower two-thirds of the abdomen. Its right extremity is in contact with the under surface of the anterior border of the right lobe of the liver, and the fundus of the gall-bladder; its left extremity is in relation with the lower extremity of the spleen, to which it is often found attached.

The *descending* colon passes from the left hypochondrium, through the back part of the left lumbar to the left iliac region, where it turns back to form the sigmoid flexure. It is much longer and smaller than the ascending division, and, like it, has immediate relations with the kidney and square lumbar muscle.

The *sigmoid flexure* varies in extent in different individuals, and being attached by a remarkably long mesocolon, is often found thrown over into the umbilical region, or even into the pelvis; this latter displacement is most apt to occur when there is large fecal accumulation in this part of the bowel.

The RECTUM,* the last division of the large intestine, commences opposite the left sacro-iliac symphysis; it descends at first a little to the right to gain the median line, and then directly downward, following the concavity of the sacrum and coccyx, to which it is attached in the upper part of its course, by a fold of the peritoneum called the mesorectum. In the lower part of its extent, it is deficient in peritoneal investment, this membrane leaving the anterior surface of the bowel, to reach the back part of the bladder in the male, and the vagina in the female. The rectum is also without the sacculated appearance presented by the rest of the large bowel. Its relations with the pelvic viscera will be noticed in the dissection of these organs.

VESSELS.—The *arteries* of the large intestine are branches of the superior and inferior mesenteric, excepting the middle and inferior hemorrhoidal arteries, which come from the inferior vesical and internal pudic, and supply the lower part of the rectum.

The *veins* form a part of the portal system, except the hemorrhoidal, which open into the internal iliac.

The *lymphatics*, properly so called, are numerous, but the lacteals are comparatively few; they enter the lymphatic glands along the

* *Rectus*, straight.

attached border of the mesocolon, and thence continue to the thoracic duct.

The *nerves*, with the exception of those distributed to the lower part of the rectum which belong to the cerebro-spinal system, are subdivisions of the solar plexus.

STRUCTURE OF THE STOMACH AND INTESTINES.

The stomach and bowels are composed of four separate layers, or *coats*, placed one within the other, and continuous throughout the whole length of the canal. They are, commencing with the external, the serous, muscular, fibro-cellular, and mucous.

The *serous coat* is a continuation of the peritoneum, which, as before mentioned, invests no part of the tube completely, and in some places is wanting to a considerable extent. Thus, on the stomach, it is deficient along a narrow space upon the superior and inferior borders, where the two layers of the omenta separate. On the first part of the duodenum, it is arranged as upon the stomach; on the second, or vertical portion, it exists only upon the anterior surface; and on the third, or transverse division, it covers the superior and inferior surfaces. It almost completely invests the jejunum and ileum, being deficient only along the narrow attachment of the mesentery. On the large bowel, as already described, it varies in its extent at different parts, and is entirely wanting at the lower part of the rectum.

The serous coat assists in giving strength to the canal, and furnishes a smooth surface for the several parts to glide upon one another and upon the surrounding structures. Although possessing little or no elasticity, it allows an almost unlimited dilatation by the separation of its reflected layers.

The MUSCULAR COAT is situated within the preceding, to which it is attached by short areolar tissue. It may be seen by dissecting off the external layer, or, without any dissection, by holding a piece of the stomach or bowel between the eye and the light. The thickness of this tunic and the disposition of its fibres, which belong to the involuntary or non-striated variety, differ in the different divisions of the canal.

1. *On the Stomach.*—The muscular tunic of the stomach consists of three separate sets, or lamellæ, distinguished from each other by the direction of their fibres. The *longitudinal* fibres are con-

tinuations of the longitudinal fibres of the œsophagus, and spread out upon the organ from the œsophageal orifice towards the pylorus. They are few and scattered upon the anterior and posterior surfaces, more numerous in the neighborhood of the pylorus, and collected into a well-marked band along the superior and inferior borders or curvatures. The *circular* fibres embrace the organ transversely, forming right angles with the preceding, beneath which they are situated. They are few and indistinct upon the left extremity, numerous and well developed in the middle and right extremity, and where the stomach joins the duodenum, are collected into a distinct annular bundle, forming a true sphincter muscle, by the contraction of which the pyloric orifice may be entirely closed. The *oblique* fibres exist only on the left or great extremity. They are not very numerous, and extend from above obliquely downward, toward the anterior and posterior surfaces of the body of the organ, where they gradually disappear.

2. *On the Small Intestine.*—The muscular fibres of this division of the tube are longitudinal and circular, the latter being situated within the former. The *longitudinal* fibres are few and scattered, except along the posterior border of the intestine where they are collected into a band; no single fibre, however, exceeds a few inches in length.

The *circular* fibres are very numerous, and form a continuous layer from the pylorus to the termination of the ileum. They are most largely developed in the jejunum, and it will be noticed that each fibre stops short of a complete ring, or that its extremities pass by each other.

3. *On the Large Intestine.*—Here also there are longitudinal and circular fibres, but they are arranged differently from the preceding. The *longitudinal* fibres are collected into three flattened bands, which are nearly equidistant and extend from the cæcum to the rectum, where they become spread out into a uniform layer of considerable thickness. These bands are considerably shorter than the intervening walls of the bowel, and give rise to the sacculated form of this part of the tube, as may be proved by dividing them at various points, when the saccules will be found to disappear, and the length of the bowel to be materially increased. The *circular* fibres pass transversely between the longitudinal bands, and are very thinly scattered over the convexities of the saccules, but in the intervening spaces, they are collected into small bundles, which project internally to form the inter-saccular septa.

In the rectum, as before mentioned, the longitudinal fibres do not collect into bands, but spread out, and terminate near the lower end of the intestine. The circular fibres here, however, increase in number from above downward, and at the lower extremity form a distinct band of considerable size, called the *internal sphincter muscle*, which contains also a few voluntary or striated fibres.

The *fibro-cellular coat* is situated between the muscular and mucous layers, and may be satisfactorily exhibited in the following manner: Take a section of small intestine, six or eight inches in length, free it from mesentery, make a few short incisions through the serous and muscular layers, and then, having turned it inside out, tie up one end and inflate it forcibly through the other. In this manner, the air is made to enter through the incisions and distend the interstices of the fibro-cellular coat, being prevented from escaping externally by the mucous membrane. If the piece of intestine is dried in its inflated condition, the mucous membrane may be afterward stripped off, leaving the fibro-cellular coat in the form of a beautiful white flocculent cylinder, supported underneath by the muscular and serous layers.

By the older anatomists, this was called, from its whiteness, the *nervous* coat, and more recently the *submucous areolar tissue.* It is found throughout the whole intestinal canal, but varies in its density and strength in different situations, being thickest in the stomach and least developed in the large intestine, and, as will be hereafter mentioned, appears to be almost entirely wanting beneath the elliptical patches of the ileum. It is to this coat that the main strength of the walls of the canal is due. It forms, in fact, the framework of the tube, serving at the same time as a bond of union between the mucous and muscular layers. It is in this coat also that the arteries divide minutely before entering the mucous membrane, and the radicles of the veins and lymphatics ramify in it before uniting to form larger trunks, so that when these several sets of vessels are injected with colored fluid, it appears more like a vascular than a cellular-fibrous structure.

The *mucous membrane* should be studied separately in the stomach, small intestine, and large intestine.

Dissection.—For this purpose, the stomach should be separated by dividing the duodenum two or three inches beyond the pylorus, and then laid open by an incision along its superior curvature, and well washed under a stream of water. The small intestine should then be severed from the mesentery, cut off within three or four inches of its cæcal termination, everted or laid open by an incision along its mesenteric border, and thoroughly cleansed.

The large bowel should be treated much in the same manner, dividing it a few inches above the termination of the ileum, in order to allow the study of the ileo-cæcal orifice.

The gastro-intestinal mucous membrane is a continuation of the same structure that lines the mouth, pharynx, and œsophagus, through which it is prolonged above into the various cavities, communicating with these divisions of the alimentary canal. It is continuous also with the lining membrane of the hepatic and pancreatic ducts, and terminates below at the margin of the anus. Like all other mucous membranes, it has an external, rough, flocculent surface, by which it is attached to the subjacent structures, and an internal free surface, smooth and slippery to the touch, constantly moistened by various secretions, and in contact with the contents of the canal.*

In the stomach, the *gastric* mucous membrane, in a perfectly healthy individual, is of a pinkish gray color, the degree of the pink hue varying according to the state of digestion, being greatest shortly after the introduction of food, and least during the quiescent state of the organ. In ordinary examinations, however, this healthy color is rarely met with, even in persons who manifested no gastric disease, on account of the rapid changes which the membrane undergoes after death. Hence it is not uncommon to find brown or black patches along the inferior curvature, or streaks of black over the course of the large veins, and frequently a pale tumid appearance from the collection of fluid in the cellular coat—changes that are apt to deceive students, and others who are not well skilled in *post-mortem* appearances. Its thickness depends very much upon the same circumstances that influence its color, but in general is greatest in the neighborhood of the pyloric extremity, and along the inferior curvature.

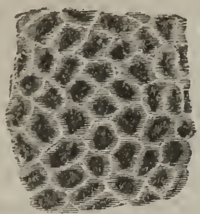
When the stomach is empty and contracted, the mucous lining presents numerous folds or *rugæ*, which are mostly longitudinal and situated along the inferior curvature. They are due to the want of elasticity in the membrane, and to the loose nature of the subjacent fibro-cellular coat, and are all effaced when the organ is distended. At the pyloric extremity, however, there is a permanent fold called the *pyloric valve*, which is annular and nearly half an inch in breadth, and has a gastric and a duodenal surface, and a sharp free edge, which defines the opening (pyloric orifice) between the stomach

* For an account of the structure and distributions of mucous membranes in general, see page 22.

and duodenum.* This valve incloses the circular band of muscular fibres already mentioned.

Examined with a simple lens, the gastric mucous membrane seems to be traversed by an immense number of raised lines or crests, in-

Fig. 146.



Gastric pits. Inner surface of the stomach, from which the mucus has been washed to show the honeycomb appearance of the mucous membrane.

Fig. 147.

A. A lateral view of the gastric tubules magnified three diameters. B. Another series of the same much more highly magnified. (After Wagner.)

closing (Fig. 145) polygonal-shaped depressions or pits (*alveoli*), about $\frac{1}{150}$ of an inch in diameter, which are particularly well seen toward the pyloric extremity. At the bottom of these pits, and upon the surface of the intervening crests or septa, may be observed an immense number of minute foramina leading to small tubes (*tubuli*) (Fig. 147 *a*, *b*), which, upon a vertical section of the membrane, are found to be nearly straight, varying from $\frac{1}{60}$ to $\frac{1}{20}$ of an inch in length, and about $\frac{1}{400}$ of an inch in diameter. They are arranged parallel with each other, and perpendicular to the surface, and consist of an inversion of the mucous membrane in an attenuated form. In all probability, they are the organs from which the gastric fluid is secreted. Besides the pits and tubules, the gastric mucous membrane presents numerous scattered lenticular follicles, often forming distinct elevations with a little depression at the centre. They are found in greatest numbers in the pyloric extremity, and are best seen in the stomachs of young persons.

The epithelium of the gastric mucous membrane belongs to the columnar variety. Its commencement at the cardiac orifice is

* The mucous membrane on the gastric side of the valve is supposed to differ somewhat in structure from that presenting toward the duodenum, from the fact that inflammations of the stomach often end abruptly at the free margin.

marked by a festooned border, which limits the pavement epithelium of the œsophagus, and may sometimes be seen with the naked eye.

In the Small Intestine.—The mucous membrane of the small intestine differs from that of the stomach in the following particulars: 1. It presents numerous permanent folds ; 2. Its surface is studded with numberless little processes called *villi*, which exist upon no other mucous surface ; 3. It contains numerous glands that are unlike any found in the stomach.

1. The *folds*, improperly called *valves* (*valvulæ conniventes*), are found throughout the whole of the small bowel to within a few feet of its cæcal termination ; but they are most numerous in the lower two thirds of the duodenum and upper half of the jejunum. They are placed transversely as regards the axis of the canal ; and do not form complete circles, but are generally crescentic, and vary much in size, some measuring half an inch at their broadest part, and others only a line or two. Commencing in the duodenum, about two inches below the pylorus, they are at first few and small, but increase very rapidly in size and number, so that, in the lower part of the duodenum and upper part of the jejunum, they nearly overlap each other : from these points they gradually diminish, and in the lower part of the ileum are almost entirely wanting. Their use seems to be to increase the extent of the membrane, and consequently its absorbing surface, and also to delay the passage of the food. Being composed only of mucous membrane doubled upon itself, they do not possess the power of contracting like the pyloric valve, but no doubt suffer a kind of erection during digestion, owing to the large amount of blood which their vessels contain at this time.

Fig. 148.

A highly magnified view of a single villus, showing the branching of its lacteal vessel.

2. *The Villi.*—If a portion of the mucous membrane of the small bowel is examined with a microscope, its free surface will be found covered by innumerable little hair-like processes or villi, varying from four to seven-tenths of a line in length, having a cylindrical, fusiform, or foliaceous shape, and so thickly set as to form a distinct layer like the *pile* of velvet. They are largest and most numerous in the duodenum and jejunum, and become gradually smaller and more scattered toward the* lower part of the ileum.

* As many as four thousand of these little bodies have been counted upon a single square inch of membrane.

Considered as a separate organ, each villus consists of a prolongation of the proper mucous tissue covered by its epithelium, and contains the ramifications of an arterial twig, the radicles of a small vein, the commencement of a lacteal vessel, and, in all probability, one or more ultimate nervous filaments. The precise arrangement of these vessels, however, has not been accurately ascertained. But, in regard to the lacteal, it has been established that this vessel, which was at one time supposed to commence upon the extremity of the villus by an open mouth, consists of three or four minute blind radicles, which ramify beneath the epithelium, and form a single trunk at the base of the villus.

3. The *glands* of the small intestines are: 1, the crypts of Lieberkuhn; 2, Brunner's glands; 3, the solitary glands; 4, Peyer's or the agminated glands.

The *Crypts of Lieberkuhn* do not differ, to all appearances, from the tubules of the stomach, except that they are scattered instead of being arranged closely together. They are found in all parts of the small bowel, and open, by minute orifices, upon the free surface of the membrane.

Brunner's Glands have been demonstrated only in the duodenum and the first few inches of the jejunum; they are most numerous immediately below the pylorus, where they form a distinct layer beneath the membrane. They are true compound glands, and consist of small lobules or granules, collected into rounded masses, situated in the submucous cellular tissue, each provided with a common ramified duct opening upon the free surface of the mucous membrane. Their secretion bears a close resemblance to that of the pancreas and salivary glands.

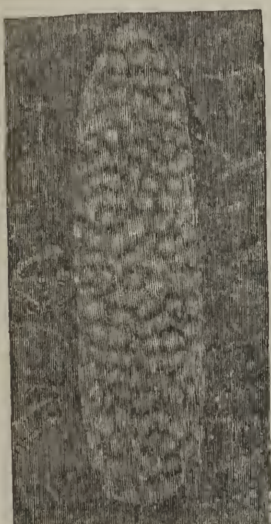
The *Solitary Glands* are found in all parts of the small intestine, but except when enlarged, as in inflammation of the bowels, cannot be readily seen with the naked eye. Under the microscope, they appear as small rounded bodies placed in the substance of the membrane, and forming a slight elevation upon its free surface. They have no excretory duct, but consist of closed cavities or cells covered by epithelium and villi, surrounded on all sides by the crypts of Lieberkuhn, and containing an opaque whitish fluid abounding in fine granules.*

The *Glands of Peyer*, called also the *agminated glands*, do not appear to differ from the solitary glands except in their mode of dis-

* Quain.

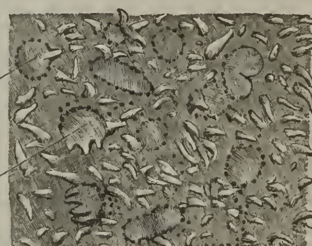
tribution. They are situated for the most part in the lower third of the small bowel, and are collected into oval or elliptical patches, varying in size from that of a three cent piece or even less, to three or four inches in length. They vary in number from twenty to forty, although, in a single instance, the author counted as many as fifty-four. They are found only along the free border of the intestine (*i. e.* opposite the mesenteric attachment), at the distance of a few inches or a foot or more from each other, becoming smaller and more scattered from below upward, and disappearing entirely some distance below the duodenum. When not altered by disease, they are frequently difficult of detection, but guided by the fact that they are generally somewhat depressed below the surrounding surface, and never crossed by the transverse folds (valvulæ conniventes), the student will always be able to find them.*

Fig. 149.



A patch of Peyer's glands, natural size.

Fig. 150.



Peyer's glands, highly magnified. (From Mandl.)

Examined with an ordinary pocket-glass, or under favorable circumstances with the naked eye, the surface of each patch will be found to be covered with villi, and to present a pitted or honeycomb appearance. This pitted appearance is due to the depressed situation of numerous closed vesicles or cells, which closely resemble the solitary glands, and like these, contain an opaque milky fluid and numerous minute granules. The mouths of numerous crypts of Lieberkuhn (Fig. 150), surround each one of the closed cells.

The function of the solitary and agminated glands is wholly un-

* Another, and a very good way to find them, is to inflate the cellular coat (see page 325), which, being exceedingly close and dense beneath the patches, is not filled by the air.

known. In a pathological point of view, the latter have excited considerable interest, on account of their connection with typhoid fever.

In the large intestine, the mucous membrane of the large bowel is paler and thinner than that of any other part of the alimentary canal. It is destitute of folds like those of the small intestine, but is disposed in the form of large pouches called sacculi, which form three rows between the longitudinal bands, and those of each row are separated from each other by transverse crests or septa inclosing fascicules of muscular fibres. It is entirely destitute of villi, but when examined with a microscope, is found to contain a large number of the crypts of Lieberkuhn, which are longer and more closely set than those of the small bowel. Scattered throughout the whole extent of the membrane, may also be observed numerous little glands or follicles, measuring from $\frac{1}{3}$ to $\frac{1}{2}$ of a line in diameter, and consisting of a single dilated sac, with a narrow orifice communicating with the free surface.

Ilio-Cæcal Valve.—The student should now examine the opening of communication between the ileum and large bowel, which may be done upon the dried preparation or upon the fresh specimen suspended in water.

The termination of the ileum is situated upon the inner wall of the large bowel at the junction of the cæcum and colon. When ex-

Fig. 151.

Ilio-cæcal valve. *a*. The terminal part of the ileum. *b*. The ilio-cæcal valve. *c*. The cæcum. *d*. The vermiform appendage. *e*. The commencement of the colon.

amined from within, it is found to consist of two horizontal prominent lips, and an intervening transverse slit like a buttonhole, about three-fourths of an inch in length. The lips, of which the superior is much

the broader, are composed of the mucous membrane, fibro-cellular coat, and muscular fibres, which are continued outward from the angles of the valve in the form of two small horizontal folds. The mechanism of the valve is very simple.

In the passage of matters from the ileum the lips separate and the opening is dilated, but if the pressure is made from the opposite side, which may be done upon the dead subject by the injection of air or fluid into the large bowel, the lips are approximated and the opening closed, and the greater the distension of the large bowel the more close will be the approximation, owing to the traction of the little folds connected to the angles.

The mucous membrane of the rectum is thicker and of a much redder color, especially in the lower part, than in any of the other divisions of the large intestine. It is loosely attached to the subjacent parts, and in the ordinary state presents numerous longitudinal folds, which, however, are all effaced by distension. Besides these, there are three well-marked transverse folds of a permanent character situated within an inch or more of the anus, and liable to become the seat of disease induced by the lodgement of irritating matters, such as pieces of bone, seed, hardened feces, &c.

THE LIVER.

The liver is the largest secreting gland in the body, and weighs more than all the others together. It is situated in the upper part of the abdomen, occupying nearly the whole of the right hypochondriac and the superior part of the epigastric regions, and often a portion of the left hypochondrium. It is not, however, perfectly stationary, being depressed by the diaphragm in inspiration, and somewhat by its own weight in the different postures of the body. It is irregularly ovoidal; its long diameter is transverse, and it is flattened upon one side, and much thicker at its right than at its left extremity. It is liable to great variety in size, weight, and shape, but, in a general way, it may be stated to measure from ten to twelve inches in length, six or seven in breadth, and three to four in thickness at its thickest part, and to weigh about four pounds. It is not unusual, however, to find both the breadth and length to be about nine or ten inches or much less, and the weight may not exceed two and a half, or fall short of six pounds, within the bounds of health. As a general rule, it is larger in the male than in the female, and, in proportion to

the size of the body, very much larger in the fœtus and immediately after birth, than at any other period of life. It is of a reddish-brown color, lighter in some cases than in others, but generally dark, and not unfrequently of an olive green or bluish hue, especially upon its under surface. This olive green appearance is not unfrequently mistaken for change of structure produced by disease, but it is usually only *post mortem*.

For descriptive purposes the liver is divided into a superior and an inferior surface, an anterior and a posterior border, and a right and a left extremity.

The SUPERIOR SURFACE, when the organ is in its place, presents somewhat forward as well as upward. It is smooth and convex, and is traversed from before backward near its left extremity, and in the median line of the body, by the attachment of the suspensory ligament; it is in accurate apposition with the concavity of the diaphragm, which separates it from the right lung and heart.

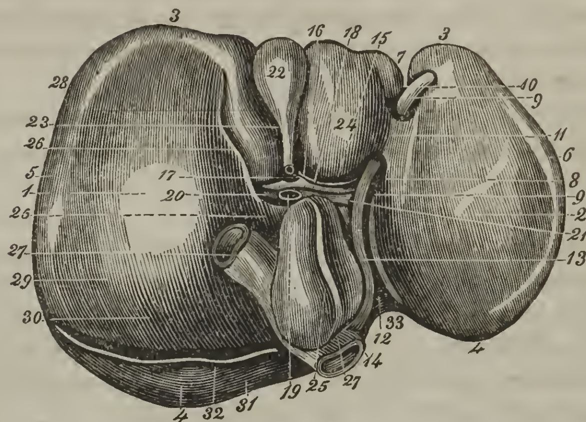
The INFERIOR SURFACE looks downward and a little backward. It is slightly concave and marked by numerous depressions, the most remarkable of which are the longitudinal and transverse fissure, the groove for the inferior cava, and the fossa for the gall-bladder.

The LONGITUDINAL FISSURE traverses the under surface antero-posteriorly, much nearer the left than the right extremity, but in the median line of the body, and in the line of separation between the right and the left lobe. Its anterior half lodges the fibrous remains of the umbilical vein of the fœtus, and on this account it is sometimes called the *umbilical fissure;* the posterior half is occupied by the remains of the venous duct (ductus venosus), a small branch of the umbilical vein. The umbilical division is often converted into an imperfect canal by a prolongation of the substance of the organ called the *hepatic bridge* (*pons hepaticæ*), in which case the umbilical vein often seems to perforate the anterior margin of the organ.

The *transverse* fissure (transverse as respects the body, but longitudinal in regard to the long axis of the organ) is situated upon the under surface of the right lobe, somewhat nearer the posterior than the anterior border. It is from one and a half to two inches in length, joins the preceding at a right angle, and transmits the portal vein, and hepatic artery, duct, and nerves.

The GROOVE FOR THE INFERIOR CAVA is placed a short distance to the right of the posterior division of the longitudinal fissure, and be-

Fig. 152.



Under or concave surface of the liver. 1. Right lobe. 2. Left lobe. 3. Its anterior or inferior edge. 4. Its posterior or diaphragmatic portion. 5. Right extremity. 6. Left extremity. 7. Notch in the anterior margin. 8. Umbilical or longitudinal fissure. 9. Round ligament or remains of the umbilical vein. 10. Portion of the suspensory ligament in connection with the round ligament. 11. Hepatic bridge or band of liver across the umbilical fissure. 12. Posterior end of longitudinal fissure. 13, 14. Attachment of the obliterated venous duct to the ascending cava. 15. Transverse fissure. 16. Section of the hepatic duct. 17. Hepatic artery. 18. Its branches. 19. Portal vein. 20. Its sinus, or division into right and left branches. 21. Fibrous remains of the venous duct. 22. Gall-bladder. 23. Its neck. 24. Lobulus quartus. 25. Lobulus spigelii. 26. Lobulus caudatus. 27. Inferior vena cava. 28. Curvature of liver to fit the ascending colon. 29. Depression to fit the right kidney. 30. Upper portion of its right concave surface over the renal capsule. 31. Portion of liver uncovered by the peritoneum. 32. Inferior edge of the right lateral ligament. 33. Depression made by the vertebral column.

longs as much to the posterior border as to the under surface of the organ; it is from an inch to an inch and a half in length, nearly an inch in breadth, and directed somewhat obliquely from behind forward and toward the left. It is occupied exclusively by the ascending cava, which here receives the hepatic veins, and is so closely connected to the tissue of the organ that it cannot readily be dissected off.

The FOSSA FOR THE GALL-BLADDER is a shallow excavation situated in front of the right extremity of the transverse fissure, and occupied, as its name indicates, by the receptacle for the bile, which is here attached by the peritoneum and areolar tissue, and may be dissected off without any difficulty. To the right of this fossa, the under surface of the right lobe is sometimes marked by a slight excavation, corresponding to the superior extremity of the right kidney and supra-renal body, and somewhat nearer the right extremity and

anterior border, by a short superficial depression for the right extremity of the transverse colon, but these are by no means distinct or constantly present.

LOBES.—By the longitudinal fissure underneath, and the attachment of the suspensory ligament above, the liver is divided into a right and left lobe. The *left lobe* is always much smaller than the right, but by no means constant in size and shape, being sometimes not more than an inch or an inch and a half in breadth, and in other cases as large as a man's open hand, and shaped somewhat like it. The *right lobe* is uniformly smooth upon its upper convex surface, but underneath it is divided into three minor lobes, called, respectively, the Spigelian, caudate, and quadrate lobes, of which only the first mentioned deserves the name. The *Spigelian** *lobe* (*lobulus Spigelii*) is a small, prominent, quadrangular pyramidal eminence situated behind the transverse fissure, and between the groove for the ascending cava and the posterior division of the longitudinal fissure. Its two lateral surfaces are abrupt, and the right somewhat excavated by the groove for the cava; the inferior is smooth and slightly convex; its posterior extremity or apex is but slightly raised above the surrounding parts; the anterior extremity or base, constituting the prominent posterior margin of the transverse fissure, is in relation with the portal vein and smaller curvature of the stomach, and runs off toward the right in the form of a tail-like prolongation, which has been dignified by the title of *caudate lobe* (technically and more high-sounding, *lobulus caudatus*). The *quadrate* or *anonymous lobe* (*lobulus quadratus*) is even less like a lobe than the caudate; it is only a quadrangular space, marked off upon the inferior surface *behind* by the transverse fissure, *laterally* by the fossa for the gall-bladder and anterior division of the longitudinal fissure, and, *in front*, by the anterior margin of the organ.

The *posterior border* is thick and rounded, and notched for the reception of the spine and the great vessels lying in front of it. On each side, it is in contact with the diaphragm, to which it is attached by the reflections of the peritoneum which form the lateral ligaments of the organ, and by intervening areolar tissue. The *anterior border* is thin and sinuous, and marked by two notches, one of which corresponds to the anterior extremity of the longitudinal fissure and lodges the remains of the umbilical vein, and the other, to the fundus

* Spigelius, Professor of Anatomy and Surgery at Padua, died 1625, A. D.

of the gall-bladder; the latter, however, is often wanting. This border is in relation, on the right side, with the inferior margin, the thorax, and the transverse colon; and, on the left, it lies between the stomach and the diaphragm.

The *right extremity* presents a thick rounded border behind, becomes narrow in front, and is in close contact with the diaphragm nearly as far as the anterior border. The *left extremity* forms a thin sharp lip, usually resting upon the anterior surface of the stomach, but not unfrequently in contact with the superior extremity of the spleen.

LIGAMENTS.—The liver is held in its position by the peritoneum, whose reflections are here called ligaments; of these, there are properly but three, the two lateral, and the suspensory or falciform. 1. The *right lateral ligament* is the continuation of the peritoneum from the under surface of the diaphragm to the posterior border of the right lobe; it is very short and strong, and consists of two layers, which, however, are separated from each other nearly the entire thickness of the border, the intervening space being connected to the diaphragm by areolar tissue. The *left lateral ligament* connects the posterior border of the left lobe to the diaphragm; it is longer than the preceding, and its two layers are in contact. The *suspensory ligament* is formed by a continuation of the anterior layer of the lateral ligaments. It is attached, on the one hand, to the superior surface of the liver, opposite the division between the right and left lobes, and, on the other, to the middle line of the anterior part of the diaphragm, and to the middle line of the anterior abdominal wall, reaching as far as the umbilicus. Its inferior margin incloses the fibrous remains of the umbilical vein, which is sometimes called the *round ligament.* When the suspensory ligament joins the lateral, its two layers diverge, and, together with the posterior layer of the lateral, inclose a triangular space on the posterior border of the organ, which is connected to the diaphragm by areolar tissue. The three layers forming the margins of this space have been, without any reason whatever, denominated the *coronary ligament*, a distinction and name which, strange to say, is still adhered to by most anatomists of the present day.

VESSELS AND NERVES.—The vessels which enter the liver are the portal vein and hepatic artery; and those emerging from it, are the hepatic duct, lymphatics, and hepatic veins. All, with the exception of the veins (which open along the groove for the cava), are

found within the transverse fissure, and should be drawn out with a tenaculum and dissected separately, in order to be seen to advantage.

The *hepatic artery* has been already described. It is a branch of the cœliac, passes upward between the layers of the hepatico-gastric omentum, enters the transverse fissure with the portal vein behind, and the hepatic duct in front, and ramifies throughout the organ, always in connection with these two vessels.

The *portal vein*, like every other vein in the body, is formed by the union of smaller veins, but, unlike any other, it divides again and ramifies precisely as an artery. It has been aptly compared to a tree, of which the roots are represented by the mesenteric, splenic, and gastric veins, and their collateral branches; the trunk, by the single large vessel formed by the union of these; and the branches, by the subdivisions of the vessel in the substance of the liver. These three divisions constitute what is called the *portal system*, which belongs exclusively to the digestive apparatus, and has little or no communication with the general venous system of the body. The blood which is circulated by this system is received from the stomach, small and large intestines, spleen and pancreas, and, as will be hereafter mentioned, probably, also from the liver itself; it undergoes certain changes in the organ, and is then poured through the hepatic veins into the ascending cava.

Fig. 153.

1. Liver. 2. Stomach. 3. Spleen. 4. Pancreas. 5. Vertical portion of duodenum; ascending portion cut away. 6. Ascending colon; transverse colon removed. 7. Small intestine. 8. Descending colon. *a*. Main trunk of portal vein. *b*. Splenic vein. *c*. Gastric vein. *d*. Inferior mesenteric vein. *e*. Superior mesenteric vein. *f*. Superior mesenteric artery, cut.

The main trunk of the portal vein (Fig. 153, *a*) is the continuation of the superior mesenteric vein (*e*), after its union with the splenic vein (*b*) behind the pancreas, from which point it ascends a little to the right, enters the

transverse fissure behind the hepatic artery, and divides immediately into two principal branches, one for the right, and the other for the left lobe.

The *hepatic duct* lies in front of the hepatic artery, from which it may be readily distinguished by the bright yellow color given to it by the *post-mortem* transudation of its contained bile. It commences in the substance of the liver by minute radicles, and these uniting with each other, form two principal trunks, which may be seen converging at the bottom of the transverse fissure, from which point it is directed outward and a little forward, between the layers of the hepatico-gastric omentum. At about an inch or an inch and a half from the liver, it unites at an acute angle with a similar vessel from the gall-bladder called the *cystic duct* (Fig. 155); the two form the *common bile duct* (*ductus communis choledochus*), which continues in the same direction as the hepatic duct, and is placed between the head of the pancreas and the descending division of the duodenum. Here it is joined by the excretory duct of the latter organ, and the two, lying side by side, perforate the left wall of this portion of the intestine obliquely, and open upon its internal surface by a small common orifice, about three and a half or four inches below the pylorus, the terminal point being marked by a little elevation or papilla of the mucous membrane.

The walls of the hepatic and common bile ducts consist of an external coat of fibrous or dense areolar tissue, and of an internal lining of mucous membrane, whose free surface is covered by a columnar epithelium, and marked by the openings of numerous little glands, the precise character of which is not known.

The *hepatic nerves* are derived principally from the solar plexus, a few filaments coming also from the pneumogastric. They are very small but numerous, and they enter the organ supported by the walls of the vessels, particularly the artery, around which they form an intricate network, known as the *hepatic plexus.*

The *lymphatics* are very numerous and comparatively large. They emerge not only at the transverse fissure, but also along the posterior border of the organ.

The *hepatic veins* ramify through the liver, separate from the portal vein, hepatic artery, and hepatic duct, and, converging toward the posterior border of the organ, open into the inferior cava by two or three very large, and several smaller trunks.

Coverings.—The liver receives an investment from the peritoneum, which, however, is deficient on the posterior border of the

organ, along the attachments of the suspensory ligament and hepatico-gastric omentum, and in the fossa of the gall-bladder.

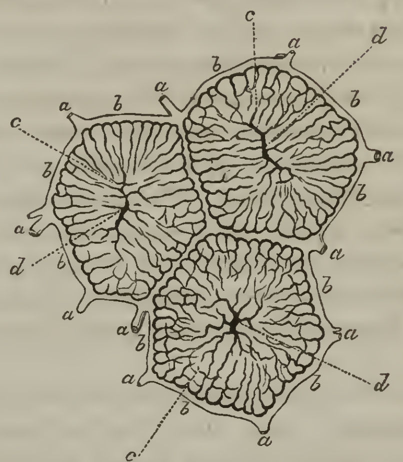
Beneath the peritoneal coat, and connected to it so closely that the two can only be separated with the greatest difficulty, is the CAPSULE OF GLISSON, of which so much has been said, to the confusion of students who study the anatomy of the liver for the first time. This capsule is nothing more than an exceedingly thin layer of fibro-vascular tissue, which invests the exterior of the organ, and is prolonged internally into numberless little processes; these intersect each other in every direction, and form minute compartments or interspaces for the lodgement of the hepatic granules or *acini*, as they are more technically called. The areolar tissue that connects the hepatic artery, hepatic duct, and portal vein, in their subdivisions and ultimate ramifications, is necessarily continuous with the walls of these compartments, and hence the statement of many anatomists that the capsule of Glisson enters the liver at the transverse fissure.

STRUCTURE.—If a portion of the liver is torn, and the lacerated surface examined with a pocket-lens, it will be found to consist, in a great measure, of minute rounded bodies, called indiscriminately *granules*, *acini*, or *lobules*, closely packed together, but separated by delicate laminæ of Glisson's capsule, which, in this situation, is often called *interlobular* areolar tissue. Each of these granules, which rarely exceed the size of the smallest mustard-seed, is a miniature representation of the whole organ; for the liver is only a mass of granules held together by Glisson's capsule and its prolongations, and by the external peritoneal covering. Each one is provided with a branch of the portal vein, and hepatic artery, duct, and vein, the larger branches of which are situated in the adjacent interlobular areolar tissue. Besides these vessels, every lobule gives origin to a small *proper* vein, which is continuous by its capillary radicles with the capillary terminations of the hepatic artery, and opens after a very short course into the minute subdivisions of the portal vein. The discovery of these small veins is one of the recent results of the microscope in the hands of Mr. Kiernan, to whom the credit is entirely due of having thus demonstrated that the venous blood of the liver, resulting from the ordinary process of nutrition, is added to the portal blood from the other digestive organs. A description of the particular arrangement of these several bloodvessels and the radicles of the hepatic duct, has also been attempted by Mr. Kiernan, but cannot be introduced here on account

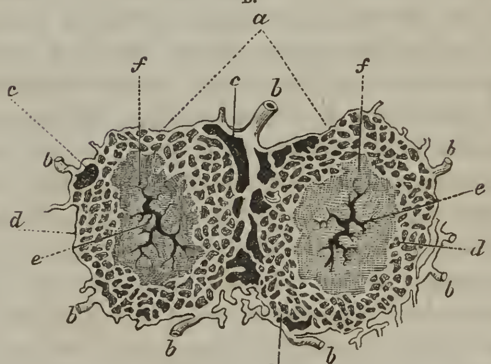
of its length, and inappropriateness to a book on dissections. The accompanying plate, however, will give some idea of the arrangement of the vessels of a single granule.

Fig. 154.

A.



B.



A, represents the vascular system as seen in three lobules. *a, a, a.* Interlobular veins contained in the spaces. *b, b, b.* Interlobular veins which occupy the fissures, and which, with the veins in the spaces, form venous circles around the lobules. *c, c, c.* The lobular venous plexuses, the branches of which, communicating with each other by intermediate vessels, terminate in the intralobular veins. The circular and ovoid spaces seen between the branches of the plexuses, are occupied by portions of the biliary plexuses, constituting the acini of Malpighi. *d, d, d.* The intralobular branches of the hepatic veins, in which the vessels of the plexuses terminate. (Kiernan.)

B, represents the interlobular ducts entering the lobules and forming the lobular biliary plexuses. *a.* Two lobules. *b, b, b.* Interlobular ducts. *c, c, c.* The interlobular cellular tissue. *d, d.* The external portions of the lobular biliary plexuses injected. *e, e.* The intralobular branches of the hepatic vein. *f, f.* The uninjected central portions of the lobules. The interlobular ducts are here represented anastomosing with each other; but Mr. Kiernan remarks that he had not seen this communication. He infers the anastomosis from collateral circumstances. (Kiernan.)

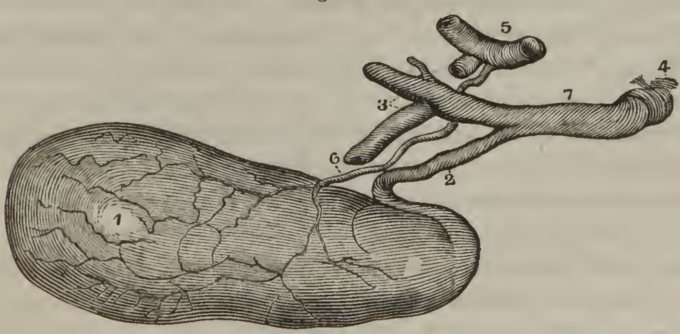
If the several sets of vessels belonging to the liver are injected with different colored substances, it will be found upon dissection that the portal vein, hepatic artery and duct, nearly as far as their most minute divisions, are always in company, and that they are connected to the surrounding tissue by a common areolar sheath, which is continuous with the interlobular prolongations of Glisson's capsule, and being rather lax, allows the vessels to close when divided, as may be readily seen upon making a section. The hepatic veins, however, ramify by themselves; they consist of exceedingly thin walls, with very short connecting areolar tissue, and when divided, always present open patulous mouths.

In the fœtus, little or no blood is sent from the digestive organ to the liver, and the portal vein, which is very small, joins the umbilical vein in the transverse fissure. After birth, however, the umbilical vein is obliterated as far as the point of union between the two, and the portal vein is much enlarged; in other words, the blood from the digestive organs after birth is substituted for the placental blood of the fœtus, and occupies the same channels in the substance of the liver.

Development.—Of all the organs of the body, the liver is the first to make its appearance, and at the fourth or fifth week after impregnation, exceeds both in size and weight the whole of the remaining semifluid mass, of which the fœtus is then composed. Even as late as the fourth or fifth month, its weight is equal to that of the rest of the body, but, from this period until some time after birth, the proportion steadily decreases.

The gall-bladder may be looked upon as a kind of diverticulum from the hepatic duct, to which it bears very much the same relation

Fig. 155.



The gall-bladder and ducts. 1. Gall-bladder. 2. Cystic duct. 3. Hepatic duct. 7. Common bile duct. 4. Its termination in the duodenum. 5. Hepatic artery. 6. Cystic artery.

as the cæcum to the intestinal canal. It is a pyriform membranous sac, of variable size, measuring usually from three to four inches in length, and one inch in breadth at its widest part, and capable of containing about an ounce of fluid. It is situated in a shallow fossa upon the under surface of the right lobe of the liver, to which it is attached by areolar tissue, and by the peritoneum, which is reflected off on each side. It is in relation below with the ascending portion of the duodenum and right extremity of the transverse colon. Its *fundus* or bottom usually projects a few lines beyond the anterior margin of the liver, and is in contact with the anterior abdominal wall, near the cartilage of the tenth rib. Its *neck* is formed by the gradual narrowing of the body behind, and is remarkable for its curved direction, which is correctly represented by the italic letter *s*.

The walls of the gall-bladder are composed of three coats, one partial and two complete. The *external* or *partial coat* is serous, and derived from the peritoneum, which invests the lower half or two-thirds of the sac, and is reflected off on each side to the under surface of the liver. The *middle coat* is a cellulo-fibrous structure and the framework of the organ.* The *internal coat* is mucous; it is a deep yellow color after death, owing to the imbibition of bile, but a grayish pink during life. The free surface of this membrane presents a beautiful honeycomb appearance, and is marked by numerous crests or folds intersecting each other in every direction, and inclosing polygonal spaces, which are again subdivided by still smaller crests into alveoli or pits, visible through a common magnifying-glass. The epithelium is of the columnar variety.

The *cystic duct* is the continuation of the neck of the gall-bladder, and is composed essentially of the same structures. It is about the size of a crow-quill, measures an inch or more in length, and is directed downward and a little forward between the layers of the hepatico-gastric omentum to unite at an acute angle with the hepatic duct. The union of the two constitutes the common bile duct. Its internal or mucous coat is similar to that of the gall-bladder, but presents a remarkable valve-like, spiral fold which is permanent, and evidently intended to divert the bile from the hepatic duct. In order to see this valve it is necessary to inflate and dry the duct, and then lay it open in a longitudinal direction.

The gall-bladder is supplied with blood through the *cystic artery*, a small branch of the hepatic, which ramifies between its coats and terminates in the mucous membrane.

* In the ox, this coat is distinctly muscular.

THE PANCREAS.

The pancreas (Fig. 145) is a long, narrow, glandular organ of a pale pinkish color, situated transversely across the upper back part of the abdomen, and extending from the spleen to the descending or vertical portion of the duodenum. It is flattened from before backward, and broad at its left or duodenal extremity; it has been thought to resemble in shape a hammer, or, better, a dog's tongue. It is moderately firm in its texture; it measures from six to eight inches in length, one to one and a half in breadth, and from four to six lines in thickness, and weighs from two to two and a half ounces. Its right or large extremity, called also the *head*, is embraced by the curvature of the duodenum, to whose vertical portion it is closely attached by areolar tissue, and by the pancreatic duct. Its left extremity or *tail* is in contact with the concave surface of the spleen.

The *anterior surface* is loosely covered by peritoneum, and is in relation with the posterior surface of the stomach, by which it is entirely concealed from view when the abdomen is first opened. The *posterior surface* rests upon the aorta, inferior cava, and left suprarenal capsule, to all of which it is attached by open areolar tissue. The *superior border* passes directly beneath the cœliac artery, and from this point to the left extremity is furrowed by the splenic artery, which is imbedded in its substance, and from which it receives a number of arterial twigs. The *inferior border* is thinner than the superior, and, near the head, is split obliquely upward and toward the right side, to give passage to the superior mesenteric artery and vein. That portion of the organ lying to the right of this fissure is somewhat separated from the remainder, and is sometimes called the *lesser pancreas.*

Structure.—The structure of the pancreas very nearly resembles that of the salivary glands, hence it has been sometimes called the *abdominal salivary* gland. It is composed of numerous lobes and still smaller lobules, held together by areolar tissue, and by vessels and ducts, and invested externally by a loose areolar net. The lobules which compose the lobes are much larger than the lobules of the liver, but, like the latter, are isolated from each other by areolar septa, and contain in their substance the ramifications of the bloodvessels and excretory duct.

The Pancreatic Duct.—The main trunk of the pancreatic duct,

generally single but sometimes double, commences in the left extremity and passes through the whole length of the axis of the gland, receiving the small ducts from the lobes, and gradually increasing in size as it approaches the head. Here it receives a large duct from the lower part of the head or lesser pancreas, and, meeting with the common bile duct from above, turns downward, enters the left wall of the duodenum, and, after passing a short distance between the coats of this intestine, unites with the bile duct, and the two open by a common orifice upon the apex of a small eminence or ampulla, about three or four inches from the pylorus.

The external coat of the pancreatic duct is composed of dense areolar tissue. The internal layer is mucous, covered by a columnar epithelium.

The *arteries* of the pancreas are derived principally from the splenic and pancreatico-duodenal, a branch of the hepatic; a small branch is also received from the superior mesenteric. The *nerves* are branches of the solar plexus.

The office of the pancreas is to secrete a clear mucous-like fluid for the purposes of digestion. The particular use of this fluid, however, is not positively ascertained, but from experiments made within the last two or three years by M. Bernard, it would seem to be intended to dissolve the oleaginous matters of the food, and thus fit them for absorption.

THE SPLEEN.

The spleen (Fig. 145) is situated in the left hypochondriac region, behind the left extremity of the stomach and the cartilages of the ninth, tenth, and eleventh ribs. It is semi-ovoid in shape, of a bluish color externally, but dark brown or brownish-red within, and although not always of the same consistence, is in general remarkably fragile or friable, and hence liable to be fractured or lacerated by external violence. On pressure between the thumb and fingers, it imparts a crackling or crepitant sensation, produced by a partial rupture of its internal structure. In point of size, no organ in the body is so inconstant within the limits of health; but its average length may be stated at about five inches, its breadth from three to four inches, its thickness one and a half inches, and its weight from five to seven ounces.

The spleen is usually single, but it is not uncommon to find in its

immediate vicinity one or more supernumerary organs of the same kind, which have generally a spheroidal form, and vary in size from that of a pea to that of a walnut. Being a half oval, it presents for consideration a convex and a flat surface, and an oval border. The *convex surface* is smooth and free, and in contact with the diaphragm by which it is separated from the lower margin of the left lung, and the ninth, tenth, and eleventh ribs. The *flat surface* is separated into two parts by a longitudinal groove or fissure called the *hilus*, which is situated a little nearer the posterior than the anterior margin, and gives passage to the vessels. It is here also that the peritoneal covering of the organ passes off to the stomach in a double fold, called the splenico-gastric omentum. In front of the hilus, this surface is in contact with the great end of the stomach and left extremity of the transverse colon; behind, it is in relation with the left kidney, supra-renal capsule, tail of the pancreas, and left pillar of the diaphragm. The *circumference* is thick and rounded, and not unfrequently notched or fissured so as to give the organ a lobulated appearance.

Structure.—The spleen consists of two investing membranes and a proper tissue. The *external* of the two coverings is serous, derived from the peritoneum, and deficient only in the longitudinal fissure. The second, or *proper* coat, is fibrous and strong, but not generally very thick, but liable to become so by disease; it is connected to the external by short, dense, areolar tissue, and prolonged throughout the substance of the organ in numerous small bands or cords (trabeculæ), which, crossing each other in every direction, inclose interspaces for containing the special tissue. This is a pultaceous, grumous-looking substance of a dark-reddish or purple-brown color, which become brighter on exposure to the air. Under the microscope, it is found to consist of minute granular bodies about the size of blood-corpuscles intermixed with tufts of arteries and veins, and groups of small white vesicular bodies called *Malpighian* corpuscles.

Vessels.—The spleen is supplied with blood by the splenic artery, a branch of the cœliac, which runs in a serpentine manner along the upper border of the pancreas and imbedded in its substance, and having reached the hilus, divides into three or four terminal branches, which enter the organ, and, what is remarkable, remain separate even to their most minute ramifications. It is, therefore, practicable to inject only one part of the organ through any one of these branches. As before mentioned, the splenic artery supplies numerous small twigs to the pancreas, and from the terminal branches in the hilus

are sent off those small recurrent arteries (gastric branches, or vasa-brevia), which, traversing the gastro-splenic omentum, are distributed upon the large end of the stomach. The *veins* are large and numerous, and all unite to form a single trunk four or five times larger than the artery, which lies in a groove upon the posterior surface of the pancreas, and unites with the superior mesenteric vein to form the portal vein. The *lymphatics* are very numerous, and form a superficial, and a deep-seated plexus, the former situated beneath the serous coat of the latter, in the substance of the organ; the two sets communicate in the fissure, and, proceeding along the gastro-splenic omentum, enter the neighboring ganglia.

The *nerves* are branches of the solar plexus, and enter the organ supported by the vessels.

The function of the spleen is not positively known, but the weight of opinion seems to be in favor of its being only a diverticulum, or reservoir for the blood, which would otherwise go to the intestines and stomach during the intervals of digestion. It is also supposed by some to be the organ in which the change from lymph globules to red globules takes place.

THE KIDNEYS.

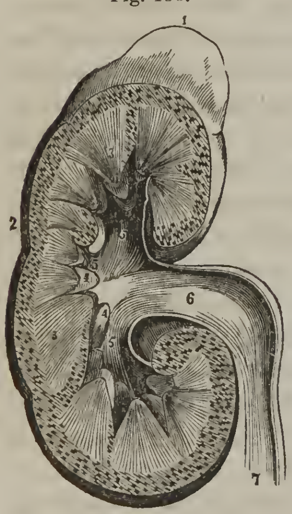
The kidneys, two in number, belong to the genito-urinary apparatus; but, having been exposed by the removal of the digestive organs, and hence, liable to become offensive, they should be now examined. They are situated deep in the lumbar regions upon either side of the spine, opposite the two inferior dorsal and two upper lumbar vertebræ; the right is generally a very little lower than the left. It is not uncommon, however, to find one or both in the iliac fossæ, and more rarely even in the cavity of the pelvis. They are of a deep brownish-red color, firm consistence, and oval figure, flattened from before backward. They measure about four inches in length, two in breadth, and one in thickness, and weigh from four to six ounces. The convex *anterior surface* looks forward and a little outward, and is loosely covered with the peritoneum lining the posterior wall of the abdomen, a quantity of adipose and open areolar tissue intervening. The *posterior surface* looks backward and inward, and rests upon the upper extremity of the psoas, the square lumbar muscle, and the lower back part of the diaphragm, by which it is separated from the eleventh and twelfth ribs. The

circumference is thick and rounded, and presents internally a deep vertical fissure called the *hilus of the kidney* (hilus renalis), at which the vessels and nerves enter and leave the organ. The upper extremity of each is embraced by the supra-renal capsule, and it is somewhat larger than the inferior, and nearer the spine, so that the axes of the two organs slightly diverge from above downward.

RELATIONS.—The right kidney is in relation, in front, with the under surface of the liver, the vertical portion of the duodenum, and the ascending colon; the left, with the posterior surface of the stomach, the lower extremity of the spleen, and the descending colon.

STRUCTURE.—Each kidney is provided with a thin but dense fibro-areolar tunic, which is closely attached to the whole of the exterior of the organ by short areolar tissue; it dips into the fissure or hilus, and becomes continuous with the external coats of the vessels. In order to demonstrate this covering, it is only necessary to make an incision along the outer border of the organ, where it may be readily stripped off from either surface by the forceps.

Fig. 156.



Longitudinal section of the kidney, with its renal capsule. 1. Renal capsule. 2. Cortical or vascular part of the kidney. 3, 3. Uriniferous tubes collected into conical fascicles. 4, 4. Papillæ, projecting into their corresponding calyces. 5, 5, 5. Dilatations of the pelvis of the kidney. 7. Ureter.

Fig. 157.

Diagram of the secretory apparatus of the kidney. 1. The renal artery, which at 2 sends a twig to the Malpighian corpuscle. 3. The convoluted tuft formed by the artery within the corpuscle. The corpuscle itself is seen at 4, and at 5 it contracts into a tortuous uriniferous tube or duct of Ferrieu. 6. The efferent vein bringing back the effete blood; this vein joins with those from other corpuscles, and thus is formed the venous plexus 7 and 9, around the uriniferous tube. These veins converge and end in the renal vein, 8.

The proper tissue of the kidney consists of two very different substances, an external, cortical or granular, and an internal or tubular, which may be easily distinguished from each other with the naked eye upon a lateral section of the organ. The *cortical*, or *granular substance* is situated externally, next the fibrous envelop, forming a layer two or three lines in thickness, with prolongations internally between the masses of tubular substance. It is moderately firm and consistent, of a reddish-brown color, and upon a clean section presents a dark-speckled, or dotted appearance, owing to the existence of numerous minute bodies called the *corpuscles of Malpighi.* The *internal*, or *tubular substance*, is of a darker color and firmer consistence than the cortical by which it is inclosed. It is disposed in pyramidal, or conoidal-shaped masses, which, when divided, present a well-marked striated appearance, produced by the parallel arrangement of the little tubes of which they are composed. The pyramids, or cones, vary from twelve to fifteen in number. Their bases are imbedded in the cortical substance, and separated from each other by prolongations of the same; but their apices are free, and present toward the fissure or hilus. The minute tubules of which these masses are composed open upon the extremities of the cones, and, traced outward, are found to run straight at first; but, having reached the bases of the cones, they ramify in a tortuous manner in the cortical substance, where they are said to terminate, or rather commence in the corpuscles of Malpighi. These corpuscles exist not only in the granular substance, but in the tubular also, and, as represented in the accompanying plate, consist each of a spherical capsule, which is the dilated extremity of a tubule, inclosing a congeries or tuft of ramified arteries and veins. Each capsule receives an arterial twig, which, dividing very minutely upon its interior, terminates in the radicles of the veins; these, uniting, form one or two main branches, which leave the capsule, and form an anastomosis around the tubule; and, then uniting with other branches, form trunks that open into the main renal vein.

The URETER, the excretory duct of the kidney, commences in the interior of the organ by small, funnel-shaped, membranous pouches, called *calyces*, which are attached around the free extremities of the cone a short distance from their apices, and embrace them as the breast-glass embraces the nipple in the operation of drawing off the milk. The calyces vary in number from eight to ten or twelve, some receiving only one cone, and others two and occasionally three. They all communicate with each other, forming one common pouch,

called the *pelvis of the kidney*, which is somewhat funnel-shaped, but flattened from before backward and bent downward. It is situated behind the renal vessels, and, when inflated, occupies nearly the whole of the fissure, a little way external to which it becomes narrowed down to the size of an ordinary goose-quill, which size it maintains throughout the rest of its course.

From the fissure of the kidney, the ureter proceeds almost vertically downward, behind the peritoneum, into the lower back part of the pelvis, where it terminates in the bladder by passing obliquely through the walls of this cavity. Its length varies from twelve to eighteen inches; its size, as just mentioned, does not usually exceed that of a goose-quill, but is liable to great augmentation when any obstacle occurs to the passage of the urine.

The ureter is covered by the peritoneum in front, and crossed obliquely by the spermatic vessels. It crosses the psoas muscle, running at first along its outer margin, and then the common and internal iliac vessels, the obturator artery and vein, and the spermatic duct.

STRUCTURE.—The ureter consists of two coats; an external, thick and fibrous, and an internal mucous coat. The former commences at the attached margins of the calyces, and terminates at the entrance of the duct into the bladder; the latter, very thin and smooth, lines the whole length of the duct, and is continued from the calyces over upon the cones, and, in an attenuated form, into the uriniferous tubules as far as the Malpighian corpuscles or capsules.

The *vessels* of the kidney have been already described. The *nerves* are numerous, and derived for the most part from the solar plexus. The branches from this plexus unite with the lesser splanchnic nerve from the thorax, and form an intricate network called the *renal plexus*, which surrounds the renal artery, and is carried by it into the substance of the organ.

The SUPRA-RENAL CAPSULES (Fig. 156) are two small glandular-looking bodies, pyramidal in shape, flattened from before backward, and resting by their bases upon the superior extremity of each kidney. The upper border or apex of each is thin, the base nearly half an inch in thickness, an inch and a half in length, and excavated for the reception of the top of the kidney. They consist of an external, thin, fibrous envelop, and an internal proper tissue divisible into an external cortical substance, of a deep brownish-yellow striated appearance, and an internal dark-brown pulpy substance, occupying

the interior of the organ. The microscopic characters of these two substances are entirely different; the cortical, consisting of minute tubes with blind extremities, which contain nucleated cells and yellowish granules; and the pulpy, of minute ramified veins, surrounded by a peculiar soft granular matter, the nature of which is not known.

Each capsule receives three minute arteries, one from the phrenic, one from the aorta, and one from the renal artery. The vein is generally single; that upon the right side opening into the cava, and that of the left into the renal vein. No excretory duct has ever been discovered coming from these organs, and their function is as yet an entire mystery. We know, however, that they have some connection with fœtal life from the fact that they are proportionably much larger at this than at any later period, and gradually diminish in size as age advances.

THE MALE PELVIS AND ITS CONTENTS.*

In the skeleton, the pelvis is that division of the trunk formed by the sacrum, coccyx, and innominate bones. It is subdivided by the promontory of the sacrum and ileo-pectineal lines, into the false, and true or lesser pelvis. In a practical point of view, however, what is called the false pelvis, namely, the space included between the flaring portions of the ilia, is properly a part of the abdomen; but the true or lesser pelvis is an entirely separate division, to which the general term pelvis will be here restricted. Considered in this light, the pelvis is a curved, cylindrical cavity, whose concavity presents forward. It communicates above with the abdomen by the large opening known as the superior strait of the pelvis, and is closed below by the soft parts designated the perineum.† Its contents are the rectum, bladder, and its appendages, internal iliac vessels and their branches, elevator of the anus, internal obturator and pyriform muscles, and sacral plexus of nerves. The perineum should be first dissected.

THE PERINEUM OF THE MALE.‡

The perineum of the male is one of the most important surgical regions of the body. It is situated at the inferior extremity of the trunk, between the commencement of the thighs and behind the

* If the subject upon which the student is engaged is a female, he may pass over this section, devoted to the male pelvis and organs of generation, and turn to the directions given for the study of the female organs of generation.

† The term perineum, when used in an obstetric sense, is limited to the space in the female included between the lower extremity of the rectum and vagina.

‡ While one student is making the dissection of the perineum, which is necessarily slow and tedious, another may be engaged upon the head preparatory to removing the brain.

external organs of generation; it extends from the point of the coccyx behind to the pubic symphysis in front, and, in a lateral direction, between the sacro-ischiatic ligaments and the tuberosities of the ischia on each side. In the ordinary positions of the body, its form is that of a narrow fissure between the thighs, but when the thighs are separated and flexed upon the pelvis, it presents itself as a quadrilateral space, measuring about four inches both antero-posteriorly and transversely.

Dissection.—Place the subject as in the lateral operation for stone in the bladder, *i. e.* flex the legs upon the thighs, and the thighs upon the pelvis, tie the hands to the feet or ankles, bring the buttocks to the edge of the table, and have the limbs held apart by a stick three or four feet long placed between the knees.

The *skin* of the perineum, as also that of the scrotum, is of a darker color than in most parts of the body, and presents in the middle line a well-marked ridge or raphé, continued forward upon the scrotum, and terminating at the anterior margin of the anus. Some distance upon either side of this ridge, the tuberosity of the ischium may be readily felt, forming the lateral boundaries of the perineum.

The anus, the outlet of the alimentary canal, is situated in the middle line at the back part of the perineal space. It is circular in shape, small but very dilatable, and always closed except during defecation. The skin in the immediate neighborhood is thin and provided with numerous sebaceous follicles and hairs, and, as it enters the opening to become continuous with the mucous membrane of the bowel, it forms a number of radiating folds. The union between the two tissues is marked by a well-defined festooned or scolloped line, situated two or three lines within the orifice.

Dissection.—Divide the skin by a transverse incision, either straight or curved, and three or four inches long, just behind the scrotum, and from its two extremities make two others running backward along the inner side of the prominences, formed by tuberosities of the ischia, as far as the level of the point of the coccyx. Turn back the flap of skin together with a small quantity of subcutaneous areolar tissue, so as to expose the superficial perineal fascia and the sphincter muscle of the anus. To assist in making a clean dissection of the latter, it will be necessary to make it tense by hooks fastened in front, and by the introduction of a piece of sponge or cotton into the rectum.

The superficial perineal fascia is a condensed layer of subcutaneous areolar tissue, such as is found in most parts of the body

subject to much pressure or tension. Anteriorly, it is tolerably dense and strong, and continuous with the subcutaneous fascia of the scrotum; it is attached by its deep surface to the tuberosity and ascending ramus of the ischium on each side. Posteriorly, it is rather loose and open, infiltrated with adipose tissue, and continued upward in front of the anus, to join the deep fascia upon the anterior surface of the rectum.

It is owing to the continuity of this fascia with that of the scrotum and its attachment to the ischia, that urine escaped from the back part of the urethra is directed forward into the scrotum, instead of passing down upon the thighs.

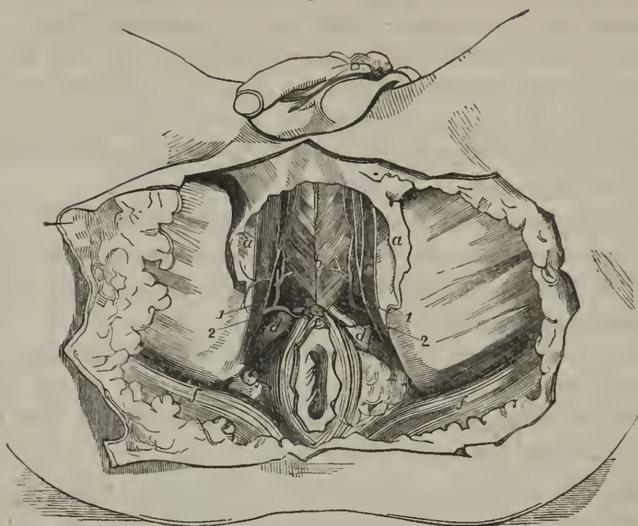
The superficial perineal fascia is in relation by its deep surface with the root of the penis, the transverse muscle, a part of the elevator of the anus, and the external sphincter muscle. To expose these structures, make the following—

DISSECTION.—Cut the superficial fascia across in front and along the rami and tuberosities of the ischia, and turn it carefully back; in doing this, observe its loose continuity with the deep fascia in front of the anus. This done, cut it off behind and proceed to dissect out the areolar tissue, which fills up the interspaces of the subjacent parts.

The space now brought into view is somewhat triangular in shape, one angle presenting forward by the converging branches of the ischia, and the two others backward and outward on each side of the anus. It contains the following structures (see Fig. 158): 1. In the middle line in front, the posterior extremity of the spongy portion of the penis, called the bulb of the penis (*b*), covered by its compressor muscle. 2. Behind, in the middle line, the anus surrounded by its sphincter muscle (*e*). 3. On each side, the leg (crus) or root of the corresponding cavernous body of the penis (*c*), diverging to its attachment along the ramus of the ischium, and also covered by a special muscle. 4. The transverse muscle of the perineum (*d*), accompanied by a very small artery and nerve. 5. A part of the lower surface of the elevator muscle of the anus, its fibres directed transversely. 6. The internal pudic artery and nerve situated deep within the tuberosity of the ischium, and close upon its inner surface; not seen in a front view of the parts.

The EXTERNAL SPHINCTER MUSCLE OF THE ANUS, thin, flat, and elliptical, consists of two lateral planes of fibres, which originate by a tendinous band from the point of the coccyx, in a curved manner around the anal orifice, and are inserted into the middle tendinous

Fig. 158.



The perineum and part of the thighs after the skin and a portion of the superficial fascia have been removed. *a*. Superficial fascia. *b*. Bulb of the penis covered by its compressor muscle. *c*. Root of the right cavernous body covered by the ischio-cavernous muscle. *d*. Transverse perineal muscle. *e*. Anterior extremity of the sphincter muscle of the anus. *f*. Edge of the great gluteal muscle. 1. Superficial perineal artery. 2. Superficial perineal nerve.

line of the perineum, a short distance back of the bulb of the penis.

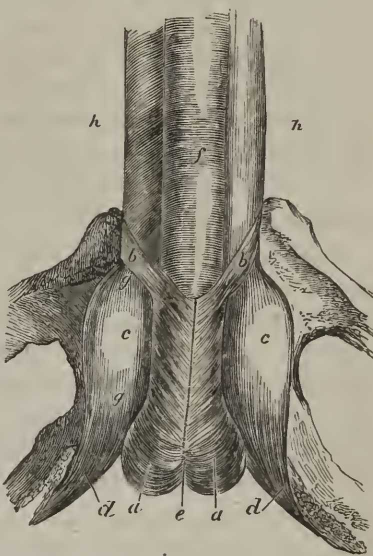
Use.—To guard the included orifice; it also makes the median raphé of the perineum tense, thus furnishing a fixed point of action for the transverse perineal muscles, and the compressor muscle of the bulb of the penis. It is supplied with arterial twigs from the internal pudic and hemorrhoidal arteries. Its nerves are offsets from the inferior hemorrhoidal, and belonging, therefore, to the cerebro-spinal system, place the muscle under the control of the will.

The *bulb of the penis*, the large, posterior, rounded extremity of the spongy portion of that organ, projects backwards nearly as far as the anterior extremity of the sphincter of the anus, resting against the deep perineal fascia; it contains in its interior, as will be hereafter described, a little offset or diverticulum from the main track of the urethra (the excretory duct of the bladder), called the sinus of the bulb.* Its surface is covered by a thin layer of muscular fibres

* In order to display the bulb to advantage, it is necessary to inflate the spongy body of the penis, which may be done through the great dorsal vein. This vessel is situated close upon the upper surface of the organ directly in the median

called the *compressor of the bulb* (*accelerator urinæ*) (Fig. 158), consisting of two lateral segments or halves which meet in a median line or raphé, extending from the anterior extremity of the sphincter of the anus along the under surface of the spongy body to the distance of an inch or more, and form a kind of muscular bag for its suspension and compression. Traced from the middle line, most of the muscular fibres will be found to surround the bulb obliquely, and meet on its upper surface, but the most anterior pass outward and forward over the cavernous bodies of the penis, to become attached to the ascending rami of the ischia. The use of the muscle is to expel the last drops of urine and semen from the urethra, and to make the median raphé tense for the action of the other muscles that are connected to it.

Fig. 159.



Parts of the pubes and ischia with the roots of the cavernous bodies attached. *a, a*. Compressor muscle embracing the bulb of the spongy body. *b, b*. Anterior slips of the same passing round the cavernous bodies to the dorsal surface of the penis. *c, c*. Roots of the cavernous bodies covered by *d, d*, the erector or ischio-cavernous muscles. *f*. Spongy body of the penis. *h, h*. Cavernous bodies of the penis.

The *roots* or *crura of the two cavernous bodies of the penis*, situated upon the sides and in front of the bulb, diverge to become attached to the rami of the ischia, and form what is commonly known as the root of the penis. Each one is covered by a small muscle called the *erector of the penis*, or more properly the *ischio-cavernous* (*c*), which arises from the inner edge of the tuberosity of the ischium by tendinous and fleshy fibres, ascends forward and a little inward upon the under surface of the corresponding root, and terminates in a thin aponeu-

line, and may be exposed by a short longitudinal incision through the skin and superficial fascia just in front of the pubis. The student must be sure he has the right vessel, for there are one or two superficial veins in this region which are apt to be mistaken for it. Having found it, open it by a small incision, and before introducing the blowpipe run a probe along its cavity in an anterior direction for the purpose of breaking down a valve situated about midway its course, which would otherwise prevent the passage of the air.

rosis, that becomes spread out and continuous with the fibrous coat of the penis. The principal use of the muscle seems to be to steady the penis during erection.

The TRANSVERSE PERINEAL MUSCLE (*d*), pale, small, and slender, and not unfrequently wanting, arises from the inner side of the tuberosity of the ischium, passes transversely and a little forward across the perineum, and is inserted into the middle raphé, just where the anterior extremity of the sphincter of the anus meets the posterior extremity of the compressor of the bulb. It is covered by the superficial, and rests upon the deep perineal fascia.

USE.—To assist the sphincter by pressing upon the anterior circumference of the anus.

Sometimes a second but very small transverse muscle (*transversalis alter*), is found running from the tuberosity of the ischium, in front of the preceding, to the compressor of the bulb.

By the transverse muscle the superficial perineal region is divided on each side into an anterior and a posterior triangular space. 1. The *anterior* or *ischio-bulbous space*, the smaller of the two and quite narrow, is included laterally between the root of the cavernous body and the bulb of the penis; upon separating which, and removing a quantity of loose areolar tissue, its bottom or floor will be found to be formed by the deep perineal fascia. It contains the superficial and transverse perineal arteries and superficial perineal nerve. The *superficial perineal artery* (Fig. 158, 1) is a small branch of the external pudic, where it lies along the inner surface of the tuberosity of the ischium; it makes its appearance upon the inner side of the origin of the erector muscle, passes forward and toward the surface, and having reached the angle formed by the cavernous and spongy bodies, is distributed to the special muscles of these organs, and the integument and under surface of the penis. The *transverse artery*, a small offset from the preceding, runs along the anterior margin of the transverse muscle, and is distributed to the sphincter, skin, and other adjacent structures. The *superficial perineal nerve* (2), also quite small, follows the artery, being derived from the internal pudic nerve which accompanies the artery of the same name. 2. The *posterior perineal* or *ischio-rectal space*, much larger than the preceding, is a deep conical excavation occupied by cellulo-adipose tissue. It is bounded externally by the inner surface of the tuberosity and body of the ischium, internally by the side of the lower extremity of the rectum, anteriorly by the transverse muscle, and deeply by the elevator muscle of the anus.

It is important as the frequent seat of suppurative inflammation, and also as the situation in which the posterior extremity of the oblique incision, made in the lateral operation of lithotomy, terminates.

The INTERNAL PUDIC ARTERY and its accompanying nerve form a very important part of the anatomy of the perineum, but they can be seen only to a very short extent in this dissection, where they lie along the inner border of the tuberosity of the ischium. The artery is a branch of the internal iliac; it descends from the cavity of the pelvis through the greater ischiatic foramen, curves over the posterior surface of the spine of the ischium, enters the lesser ischiatic foramen, and ascends forward along the inner face of the tuberosity and ramus of the ischium, nearly an inch from its inferior border, to reach the root of the penis. On account of its distance from the border of the tuberosity and ramus of the ischium, it is almost entirely out of danger in the operation of lithotomy, unless the edge of the knife is lateralized to a very unnecessary degree.* The *internal pudic* or *perineal nerve* is derived from the sacral plexus; it follows nearly the same course as the pudic artery in the perineum, lying upon the under side of this vessel, and is distributed to the integuments and muscles of the perineum and root of the penis.

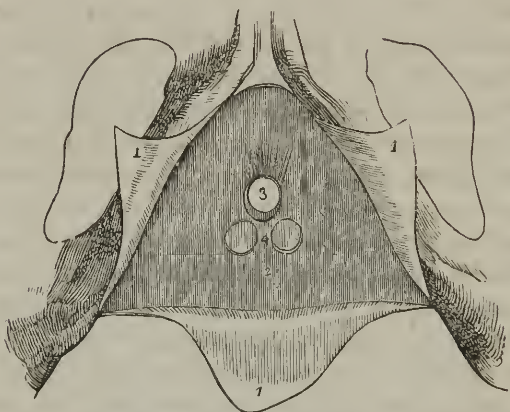
DISSECTION.—Dissect off the compressor muscle of the bulb, the transverse muscle, superficial perineal artery and nerve, and a quantity of surrounding loose areolar tissue; push the bulb to one side, and detach the sphincter in front, and the deep perineal fascia will be brought into view.

The DEEP PERINEAL FASCIA (Fig. 160), called more frequently the *triangular ligament of the urethra*, and sometimes the anterior layer of the deep perineal fascia, to distinguish it from a still deeper layer, is a thick, strong, triangular, fibrous membrane, stretched across the front of *the pubic* arch, for the purpose of closing and giving strength to this part of the inferior strait of the pelvis. It is attached on each side to the inner face of the rami of the pubis and ischium, as far

* The size of the pudic artery is subject to considerable variation; but when very small, an *accessory pudic artery* is sometimes found to exist, which generally leaves the main trunk in the great sciatic foramen, passes forward over the prostate gland, and then along by the membranous portion of the urethra, to terminate in the artery of the bulb. When present, which happily is rarely the case, this accessory vessel is very liable to be wounded in the division of the membranous portion of the urethra and prostate gland, in the lateral operation of lithotomy.

as the prominent part of the tuberosity of the latter, and is continued backward, in an attenuated form, to the anterior surface of

Fig. 160.



The pubic arch, with the attachment of the perineal fasciæ. 1, 1, 1. The superficial perineal fascia, divided by a Λ shaped incision into three flaps; the lateral flaps are turned over the ramus of the pubis and ischium at each side, to which they are firmly attached; the posterior flap is continuous with the deep perineal fascia. 2. The deep perineal fascia. 3. The opening for the passage of the membranous portion of the urethra, previously to entering the bulb. 4. Two projections of the anterior layer of the deep perineal fascia, corresponding with the position of Cowper's glands.

the lower extremity of the rectum, when it blends with the surrounding areolar tissue, and the continuation of the superficial fascia. It is perforated, in the middle line in front, for the anterior extremity of the membranous portion of the urethra, and is in relation by its anterior or superficial surface with the bulb of the penis, and the other structures already described as occupying the interval bounded in front by the superficial fascia. The opening for the transmission of the membranous portion of the urethra, is situated about an inch below the lower edge of the pubic symphysis, is circular in shape, and corresponds in size to that of the canal by which it is occupied. Its circumference does not, however, present a well-defined edge, but is continuous in front with the fibrous envelop of the spongy body of the penis, and behind with the external coat of the membranous portion of the urethra.

Dissection.—If the deep perineal fascia is detached in front, dissected from the membranous portion of the urethra, and turned back, it will be found to be continuous behind with another layer of fascia, called the posterior or internal layer of the deep perineal fascia, but which is properly a dependency of the fascia lining the interior of the pelvis. Considered, however, as a separate fascia, this third layer is attached above and laterally, to

the posterior edge of the highest part of the pubic arch, and continuous below with posterior surface of the deep perineal fascia just below its transverse middle. Above this point of union the two are separated by a small flattened triangular space, containing the membranous portion of the urethra, and its compressor muscle, the arteries of the bulb, Cowper's glands, and a large plexus of veins.

The *membranous portion of the urethra* is about an inch in length, and about the size of a large goose-quill. It is continuous behind with the prostatic, and in front with the bulbous portion of the canal, and directed from behind forward, and a little upward. In its course forward, it traverses the space just described, its anterior extremity occupying the circular opening in the deep perineal fascia or triangular ligament, and its posterior, a similar but less distinct opening in the posterior layer of the same.

Cowper's glands are two small spherical bodies of a pinkish color, and about the size of peas, situated between the two layers of the deep perineal fascia, and below the membranous portion of the urethra. They have a rough granular exterior, and resemble the salivary glands in structure, being composed of numerous little rounded lobules, held together by areolar tissue, but they do not possess a well-marked common investment or capsule. Each gland is provided with a long slender duct, which enters the wall of the membranous portion of the urethra, runs forward about half an inch between its coats, and opens into the bulbous portion of the tube. Their office is to secrete a viscid mucous-like fluid, the use of which, however, is unknown. They are in relation in front with the transverse division of the compressor muscle of the urethra, and above with the arteries of the bulb.

The ARTERY OF THE BULB (a vessel somewhat larger than the superficial perineal), is one of the terminal branches of the internal pudic, or of the accessory pudic, when this vessel exists. From its origin upon the inner side of the ascending ramus of the ischium, upon a level with the membranous portion of the urethra, it passes transversely inward behind the deep perineal fascia, curves over the corresponding Cowper's gland, to which it gives a small twig, perforates the deep perineal fascia by the side of the anterior extremity of the membranous portion of the urethra, enters the bulb, and is distributed to the spongy portion of the penis. Sometimes this vessel curves along the perineum nearer the rectum than here indicated, and is then liable to be wounded in lithotomy; but ordinarily it is too far forward to be much endangered, unless the incision is extended more than necessary in this direction.

The *compressor muscle of the urethra*, small, indistinct, and frequently wanting (or at least so imperfectly developed as often to escape a most careful examination), is situated upon the posterior surface of the deep perineal fascia. It is shaped somewhat like an inverted letter ⊥, and consists therefore of a vertical and a transverse slip. The *vertical* portion (Wilson's muscle), is made up of two small flattened fascicles of pale fibres, which originate from the inner edge of the highest point of the arch of the pubis, descend side by side, and are inserted into the membranous portion of the urethra, in connection with the succeeding division. The *transverse* division (Guthrie's muscle) consists of two lateral portions, which arise from the upper part of the rami of the respective ischia, pass almost transversely inward, and unite upon the membranous portion of the urethra with the vertical division. As its name indicates, the use of this muscle is to compress and probably close the urethra.

The *venous plexus*, also found in the space between the two layers of the deep perineal fascia, receives the dorsal veins of the penis, which perforate the anterior layer above the urethra. It is remarkable for the number and tortuosity of its vessels, which, being bound together by tolerably firm fibro-areolar tissue, do not readily collapse when divided, and are hence liable to furnish a considerable amount of blood in the operation of lithotomy.

The *posterior layer of the deep perineal fascia* cannot be very easily demonstrated. To be seen in this dissection, it is necessary to remove all the structures just described, as intervening between it and the triangular ligament or deep perineal fascia,* properly so called. It is less dense and strong than the latter, with which it is continuous below the opening for the membranous portion of the urethra, and is attached, upon either side, to the posterior edge of the highest point of the pubic arch. It is in relation in front with the structures already described in the triangular interspace, and behind, with the anterior extremity of the prostate gland, and the vesical plexus of veins. It is perforated about the middle by the commencement of the membranous division of the urethra, and from the margins of this opening, it is continued forward upon the urethra, and backward upon the prostate gland, forming the fibrous envelop of this organ.

* By the simple term, deep perineal fascia, is always meant the anterior of the two layers, which is the triangular ligament of the urethra. The posterior layer, as already mentioned, is properly a continuation of the pelvic fascia.

The ELEVATOR MUSCLE OF THE ANUS (*levator ani*), which is partly exposed in this dissection, separates the perineum from the pelvis. Its origin cannot at present be seen, but its inferior surface, which is here brought into view, is convex, and its fibres will be observed to pass transversely toward the median line, to be inserted into the lower extremity of the rectum, into its fellow of the opposite side, in the space between the rectum and bladder, and into the side of the prostate gland.

The depth of the perineum between the skin and the posterior layer of the deep perineal fascia and elevator muscle of the anus, varies in different individuals from one to two or even three inches, depending, in a great measure, upon the development of the adipose tissue in this region. This is an important fact in its connection with lithotomy, more particularly as the greater thickness does not always correspond with the general condition of the body, the development of adeps being sometimes only local. Before operating, therefore, it is proper to examine with reference to this point, which may be done by introducing a catheter into the bladder, and then, with the index finger of one hand in the rectum, pressing with the other upon the perineum.

INTERIOR OF THE PELVIS.

To study the contents of the pelvis in their natural position, it is necessary to remove one (the right is preferable) of the lateral walls of the cavity, leaving the contained organs in connection with the opposite side. This may be done in the following manner:—

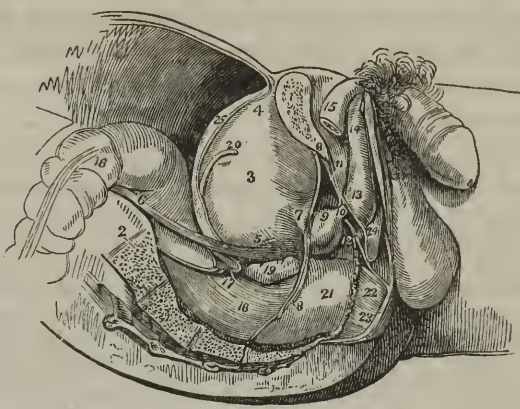
DISSECTION.—Turn the scrotum and penis to the left side, and divide the soft parts down to the pubic symphysis a little to the left of the middle line; next, carefully dissect the root of the cavernous body of the penis from the right ischium, by scraping it off with the periosteum to avoid making an opening into its substance; then cut through the pubic symphysis, separate the thighs forcibly, dissect the bladder from its connection with the right wall of the pelvis, and divide successively the corresponding half of the elevator muscle of the anus, sacro-ischiatic ligaments, sciatic nerve, pyriform muscle, and common iliac vessels; lastly, tear the right ilium from the sacrum, by separating the thighs still farther, and cut through the muscular mass behind.

The viscera will now be found in the concavity formed by the sacrum, coccyx, and left innominate bone. The first thing to be done is to sponge the parts clean, trim off the ends of the muscles, areolar tissue, and other loose structures, inflate the bladder to a moderate degree, and distend the rectum with cotton, hair, or some other such material.

Before any farther dissection is performed, the student should notice the disposition of the pelvic portion of the peritoneum. Traced from above, this membrane descends into the posterior part

of the pelvic cavity, upon the anterior and lateral surfaces of the rectum, which it attaches to the anterior surface of the sacrum by a

Fig. 161.



A side view of the viscera of the male pelvis, *in situ.* The right side of the pelvis has been removed by a vertical section made through the pubis near the symphysis, and another through the middle of the sacrum. 1. The divided surface of the pubis. 2. The divided surface of the sacrum. 3. The body of the bladder. 4. Its fundus; from the apex is seen passing upwards the urachus. 5. The base of the bladder. 6. The ureter. 7. The neck of the bladder. 8, 8. The pelvic fascia; the fibres immediately above 7 are given off from the pelvic fascia, and represent the anterior ligaments of the bladder. 9. The prostate gland. 10. The membranous portion of the urethra, between the two layers of the deep perineal fascia.* 11. The deep perineal fascia formed of two layers. 12. One of Cowper's glands between the two layers of deep perineal fascia, and beneath the membranous portion of the urethra. 13. The bulb of the spongy body. 14. The body of the spongy body. 15. The right erus penis. 16. The upper part of the first portion of the rectum. 17. The recto-vesical fold of peritoneum. 18. The second portion of the rectum. 19. The right vesicula seminalis. 20. The deferential tube. 21. The rectum covered by the descending layer of the pelvic fascia, just as it is making its bend backwards to constitute the third portion. 22. A part of the elevator muscle of the anus investing the lower part of the rectum. 23. The external sphincter. 24. The interval between the deep and superficial perineal fascia; they are seen to be continuous beneath the number, much more distinctly than is really the case.

reflected fold called the *meso-rectum.* This fold is broad above, but gradually narrows to its termination about four inches above the anus; here the membrane leaves the anterior surface of the rectum, passes forward to reach the bladder about an inch and a half or two inches behind its neck, ascends over the posterior surface and summit of this organ, and from its anterior surface reaches the anterior wall of the abdomen just above the pubic symphysis.

From the sides of the bladder, the peritoneum is reflected forward to the anterior walls of the pelvis and abdomen, forming the *anterior false ligaments* of the organ.

* The distance between the lower edge of the pubic symphysis and the membranous urethra is very much overrated in the plate.

DISSECTION.—The reflections of the peritoneum having been examined, this membrane should be dissected from the left lateral wall of the pelvis, bladder, and rectum, and turned over toward the right, so as to display the pelvic fascia and the elevator muscle of the anus.

The *pelvic fascia* is a continuation of the iliac which covers the iliac and psoas muscles, from which it descends to invest the lateral and anterior walls of the pelvic cavity. From behind the symphysis of the pubes, it is continued over the superior surface of the prostate gland to the bladder; laterally, it is more dense and strong, and near the bottom of the cavity forms a thickened band, extending, in a curved direction, from the symphysis downward and backward to the spine of the ischium. From the lower margin of this band, the elevator of the anus takes its origin, and the fascia here divides into a vesical and an obturator lamina. The *vesical* layer covers the superior surface of the elevator of the anus, from which it is continued backward upon the anterior and lateral surfaces of the rectum, and forward over the posterior extremity or base of the prostate gland to the bladder, forming, when it reaches this organ on each side, its lateral *true ligaments.* If this layer of fascia is cut in lithotomy (as is sometimes the case where a too extensive division of the prostate gland is made), death almost invariably results from extravasation of urine into the pelvic cavity beneath the peritoneum.

The obturator division of the fascia cannot be seen until after the removal of the elevator of the anus; it covers the lower part of the internal obturator muscle, and the inner face of the tuberosity and ramus of the ischium, and is continuous with, or rather forms, the posterior layer of the deep perineal fascia, as previously mentioned.

DISSECTION.—The bladder and rectum having been turned to the left, so as to put the right segment of the elevator of the anus upon the stretch, dissect the vesical layer of the pelvic fascia from the surface of the muscle.

The ELEVATOR MUSCLE OF THE ANUS (*levator ani*) is a broad, thin muscle, stretched in an arched manner across the bottom of the pelvis with its concavity presenting upward. It consists of two lateral halves or segments, which originate on each side from the posterior surface of the pubic symphysis, from the lower edge of the whole length of the thickened band of pelvic fascia, extending from the pubic symphysis to the spinous process of the ischium, and from the inner surface of this process. The fibres descend inward, and

are inserted into the side of the rectum some distance above the anus, into a median raphé extending from the rectum to the prostate gland, and into the sides of this gland.

Relations.—Its superior surface is covered by the vesical layer of the pelvic fascia, which separates it from the peritoneum behind, and from the base of the bladder in front. Its inferior surface is separated by a considerable quantity of fat, numerous veins, and the obturator layer of the pelvic fascia, from the structures constituting the deepest part of the perineum. Its anterior border is in contact with the side of the prostate, and reaches as far forward as the commencement of the membranous portion of the urethra.

Use.—To raise the rectum and bladder and the structures connected with these organs; it thus antagonizes the abdominal muscles, more particularly the diaphragm, and assists in defecation, and also in the expulsion of the semen and urine.

Dissection.—Dissect the peritoneum from the surface of the rectum and bladder.

The rectum (Fig. 161) descends obliquely from its commencement upon the left side of the promontory of the sacrum, and having reached the median line, continues along the concavity of this bone and the coccyx to the point of the latter, where it turns a little backward to terminate at the anus. It is held in its position above, to within three or four inches of its termination, by the meso-rectum, and below, by the pelvic fascia, the elevator of the anus, and a large quantity of areolar tissue, and by its attachment to the anus. It differs from the other portions of the large intestine in being smooth, cylindrical, and destitute of the three longitudinal bands and intervening saccules. It is not, however, of uniform size throughout, but an inch or two above the anus presents a considerable bulbous dilatation, which is liable to be much increased by long retention of the feces.

Relations.—It is in relation *behind* with the front of the left sacro-iliac symphysis, the concave surfaces of the sacrum and coccyx, the origin of the pyriform muscle, and sacral plexus of nerves; in *front*, with the back of the bladder, one or more convolutions of the small intestine frequently intervening, with the elevator of the anus, with the base of the bladder and the seminal vesicles that form its lateral boundary, and with the prostate gland. It is covered by the peritoneum as far down as opposite the junction of the lower two pieces of the sacrum, that is, about four inches from the anal orifice.

Structure.—Besides the partial peritoneal investment the rectum has two coats, a muscular and a mucous. The muscular tunic consists of longitudinal and circular fibres; the former are external, and form a uniform and tolerably thick layer in the upper part of the organ, but they gradually run out as they descend, and at the anus are entirely wanting. The circular fibres, on the contrary, are few and scattered above, but gradually increase in numbers, and just above the sphincter of the anus are collected into a well-defined bundle, sometimes called the *internal sphincter.* The mucous lining is thick and vascular, and but loosely connected to the muscular layer; it is thrown, at various points, into a number of temporary longitudinal folds readily effaced by distension; about half an inch or more within the anus, it presents two or three small permanent transverse folds, so disposed as to form little pockets upon the interior of the tube, with their concavities presenting upward. Sometimes these transverse folds intercept hard fecal matter and become very much stretched, and may be carried before the accumulating mass to the verge of the anus.

The *arteries* of the rectum are three in number and tolerably large; they are: 1, the superior hemorrhoidal, a branch of the inferior mesenteric; 2, the middle hemorrhoidal, a branch of the internal iliac; and, 3, the external hemorrhoidal, a branch of the internal pudic. The *veins* are very numerous, and around the lower part of the bowel form a large and intricate plexus, constituting a kind of erectile tissue not unlike that of the penis; they terminate in the inferior mesenteric and internal iliac veins. The *nerves* are filaments from the sacral, mesenteric, and hypogastric plexuses, and belong, therefore, both to the cerebro-spinal and sympathetic systems.

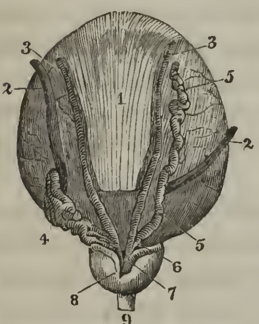
THE BLADDER.

The bladder (Fig. 162) is a musculo-membranous sac for the reception and expulsion of the urine. When contracted and empty, it is deeply situated in the anterior part of the pelvis, behind the symphysis and arch of the pubis, but when distended, it fills the greater part of the cavity of this pelvis, and encroaches upon that of the abdomen. Its form is ovoidal; the larger extremity or base presents downward and backward, resting upon the elevator of the anus and forepart of the lower portion of the rectum, and its summit presents upward and forward, behind and a little above the pubis (and is not,

therefore, correctly represented in Fig. 160). Its size varies in different individuals according to their habits, being greater in those who retain their urine long, and hence, as a general rule, greater in females than in males.

It is divided into an anterior, a posterior, and two lateral surfaces, a summit, and a base. The *anterior surface* is not invested by the peritoneum, but is connected by loose areolar tissue to the posterior surfaces and symphysis of the pubis, and the internal obturator muscles. When the organ is much distended, it is in contact also with the anterior wall of the abdomen, for the distance of an inch or more, just above the pubis and below the reflection of the peritoneum from the summit. This is one of the points where the organ may be opened without wounding the serous membrane. The *posterior surface* is free, and covered throughout by the peritoneum. It is in relation with the rectum, one or more coils of the small intestine frequently intervening, and crossed beneath its peritoneal investment and near the base of the organ, by the spermatic or seminal ducts. The *lateral surfaces* are covered by peritoneum above, but are connected below to the sides of the pelvis by loose areolar tissue and a continuation of the pelvic fascia; they are each crossed obliquely from below upward, forward, and inward, by a small fibrous cord, the remains of the hypogastric or umbilical artery of the fœtus, and in an opposite direction by the seminal duct (20) on its way from the internal abdominal ring to the base of the bladder. The *summit* or top is covered by peritoneum, and connected to the anterior abdominal wall, at the umbilicus, by a thick fibro-cellular band, the remains of the fœtal continuation of the bladder, called the *urachus*. The *base* (Fig. 162) looks downward and backward, is partly covered behind by the recto-vesical reflection of the peritoneum, and rests upon the elevator muscles of the anus in front of the lower extremity of the rectum. The ureters (2, 2) enter this part of the organ on each side behind, and the seminal vesicles and ducts cross it from behind forward and inward, inclosing a triangular internal bounded

Fig. 162.



Base of the bladder with the seminal vessels, ureters and prostate gland. 1. Muscular structure of the bladder. 2, 2. Ureters. 3, 3. Seminal ducts. 4. Seminal vesicle. 5. Same of the opposite side, dissected out to show its tubular character. 6. Efferent duct of the seminal vesicle which joins the duct of the seminal duct to form at 7 the excretory duct. 8. Prostate. 9. Urethra. (After Cruveilhier.)

behind by the reflection of the peritoneum, which corresponds to a triangular space upon the interior of the organ, called the *trigone* or *bas fond* of the bladder. This portion of the organ lies almost directly upon the lower extremity of the rectum, the elevator muscle and pelvic fascia alone intervening, and terminates anteriorly at the prostate gland, surrounding the neck of the bladder and commencement of the urethra.

The bladder is held in its position by the urethra and by two sets of ligaments called false and true. The *false ligaments* are five in number, and are formed by the reflections of the peritoneum; two of them, the posterior or recto-vesical, extend from the sides of the rectum to the base of the bladder, two from the lateral surfaces of this organ toward the crural arch, inclosing the remains of the umbilical arteries, and the remaining one from the summit to the umbilicus, inclosing the urachus. The *true ligaments*, two anterior and two lateral, are continuations of the vesical division of the pelvic fascia; the *anterior* are dense and strong, and extend from the lower back part of the pubis to the front of the neck and lower part of the anterior surface of the organ, leaving between them a cellular internal occupied by a venous plexus, in which terminates the dorsal vein of the penis; the *lateral* are broad and thin, connected by one extremity to the sides of the prostate gland and neck of the bladder, and, by the other, continuous with the fascia covering the upper surface of the elevator muscle of the anus.

Structure.—The bladder consists of a mucous and a muscular coat, and a partial investment of the peritoneum already described.

The *mucous coat*, the lining membrane, is of a light pinkish gray color. In the contracted state of the organ, it forms numerous temporary folds resembling those found in the stomach, which are effaced by distension. In addition to these, there are sometimes permanent ridges, crossing each other in every direction, produced by a hypertrophied condition of the subjacent muscular fascicles. It is continuous at the base of the cavity, in front, with the lining membrane of the urethra, and behind and external to the latter, with that of the ureters.

The openings of the ureters, about the size of a crow-quill, are situated upon a line with each other about an inch and a half apart, and the same distance from the internal orifice of the urethra, and do not correspond to the points at which these tubes reach the origin externally, but are placed about half an inch farther forward. The perforation is, therefore, oblique or valvular, an arrangement intended

to prevent reflux of the urine in the contraction of the cavity during micturition. Between the two openings the mucous membrane forms a slight transverse fold, and sometimes upon each side, a similar but less distinct one leading to the urethra. The three inclose an equilateral triangle, already mentioned as the *trigone* of the bladder, whose under surface forms the triangular space upon the base of the organ, bounded laterally by the seminal ducts and vesicles. It is in this space that the operation of puncturing the bladder through the rectum is directed to be performed.

The mucous membrane is rather loosely attached to the muscular coat except at the trigone. It is provided with simple mucous follicles, which are most numerous in the trigone and around the commencement of the urethra, and is covered by an epithelium intermediate between the columnar and squamous.

The *muscular coat* consists of fascicles of pale involuntary fibres, crossing each other in every direction, and differing very greatly in size in different individuals. It is usually considered as consisting of an external and an internal layer, the fibres of the former encircling the organ horizontally, and those of the latter longitudinally; but this distinction cannot be made out clearly, except at the base of the organ. Here the circular fibres are well marked, and at the commencement of the urethra form a distinct circular band, which is a true sphincter muscle. From this point the longitudinal fibres diverge in all directions, and are particularly well seen upon the base, along each side of which they are sometimes collected into a bundle, leading from the neck of the organ to the extremity of the corresponding ureter, and hence called the *muscles of the ureter*.

Vessels and Nerves.—The vesical *arteries* are two upon each side, and very small; the *superior* is the remaining pervious portion of the hypogastric or umbilical artery, a branch of the internal iliac; the *inferior*, situated in front of and below the preceding, is also a branch of the internal iliac. The veins, which are numerous and large, form an intricate plexus around the neck of the organ, and terminate in the internal iliac veins. The nerves are derived from the hypogastric and sacral plexuses, those from the former source being distributed to the body of the organ, and those from the latter to the base and neck.

The *neck of the bladder* is the commencement of the urethra, inclosed by the prostate gland, and will be described in connection with the

MALE ORGANS OF GENERATION.

The male organs of generation are the testes and their excretory apparatus, and the penis, with the urethra and its appendages, the prostate and Cowper's glands.* They will be here described in the order in which it is most convenient to examine them, upon the section of the pelvis already directed to be made.

The PROSTATE GLAND (Fig. 161–2, 162–8) is situated somewhat more than half an inch below the highest point of the arch of the pubis, and surrounds the neck of the bladder, and commencement of the urethra. It is a dense, whitish-looking organ, about the size and shape of an ordinary chestnut; it presents its base toward the bladder, and is directed from behind forward, and a little downward. In the adult it measures little more than an inch and a half in length, nearly an inch and a half in breadth at its broadest part, and about three-fourths of an inch in thickness. Its *superior surface* looks upward and forward, is convex, traversed in the middle by a slight antero-posterior furrow, and connected to the back part of the pubis by the reflection of the pelvic fascia, forming the anterior true ligaments of the bladder, and by the posterior layer of the deep perineal fascia. The *inferior surface*, almost flat, presents downward and a little backward; it is perforated by the ejaculatory ducts behind, and rests upon the anterior surface of the lower extremity of the rectum, through which the organ can be readily felt with the finger. Its *sides* or *borders* are thick and rounded, and inclosed by the anterior fibres of the elevator of the anus. The *base* is the broadest part of the gland, slightly convex, and in contact with the bladder on each side of its neck. The *apex* or anterior extremity is rounded and blunt, rests in contact with the posterior layer of the deep perineal fascia, and is apparently continuous with the membranous portion of the urethra.

The prostate is usually considered as consisting of two lateral *lobes*, but the mark of division is by no means distinct. A third or *middle lobe*, is also described by some anatomists as situated between the posterior extremities of the two lateral, but in a healthy condition of the organ no such lobe can be demonstrated. It is true that we sometimes find a nipple-like process of the gland pro-

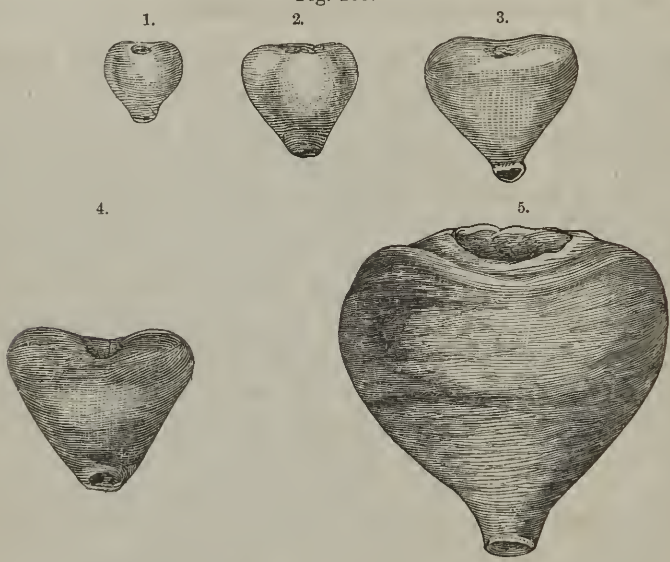
* Cowper's glands have been already described.

jecting into the neck of the bladder, but this is due to a hypertrophied condition of this particular part.

The prostate is traversed a little way from behind, forward and upward, by the ejaculatory ducts, and from its base to its apex by the first portion of the urethra.

Development.—The prostate does not attain its full size until sometime after the age of puberty. The augmentation which it

Fig. 163.



1. Prostate at birth. Width, at base, 4 lines; a little above middle, 5 lines; at apex, 2 lines; length along the middle, 4 lines, and at the edge, $4\frac{3}{4}$; thickness at base, 2 lines; at middle, $3\frac{1}{4}$, and at apex, $1\frac{1}{4}$. Weight, 13 grains.

2. Prostate at 4 years. Breadth, at base, 6 lines; just above the middle, 7; and at the apex, $2\frac{1}{2}$; length along the middle, 6 lines; and 7 lines at the margin; thickness at base, $2\frac{3}{4}$ lines; at the middle, 4; and at apex, 2. Weight, 23 grains.

3. Prostate at 12 years. Width, $8\frac{1}{2}$ lines, at base; $9\frac{1}{2}$ above the middle, and 3 at apex; length. along the middle, 8 lines, and $8\frac{1}{2}$ at the edge; thickness at base, 3; middle, $4\frac{1}{2}$; and at apex, $2\frac{3}{4}$. Weight, 43 grains.

4. Prostate at 14 years. Width, at base, 11 lines; at middle, $9\frac{1}{2}$; at apex, 4; length, along the middle, 8 lines, and 10 at margin; thickness, $3\frac{1}{2}$ at base, 5 at middle, and 3 at apex. Weight, 58 grains.

5. Prostate at 25 years. Width, at base, 18 lines; middle, 20; and apex, 5; length, along middle, 15 lines; and at edge, 18; thickness at base, 9 lines; middle, 10; at apex, 4. Weight, $4\frac{1}{8}$ drachms.

nearly always undergoes in advanced life is pathological, and is not therefore taken into account. The annexed representations, taken from a recent work* on the urinary organs, exhibit its size and form at five different ages.

* Diseases and Injuries of the Urinary Bladder, &c., by S. D. Gross, Prof. of Surgery in the University of Louisville.

Structure.—The prostate is closely invested by a dense fibro-areolar coat, continuous in front with the posterior layer of the deep perineal fascia, and behind with the pelvic fascia. The inclosed glandular substance consists of minute follicles, held together by areolar tissue, and provided with a minute excretory duct. From these several small ducts twelve or sixteen larger ones are formed, which open into the bottom of the prostatic portion of the urethra, upon each side of the gallinaginous or urethral crest, as will be seen when this portion of the urethra is under examination.

The *arteries* of the prostate are small branches of the pudic, vesical, and hemorrhoidal. The *veins* open into the surrounding plexus. The *nerves* are offsets from the hypogastric plexus.

The secretion of the prostate is of a mucous-like character, and said to be acid in its reaction, but its use is unknown.

THE PENIS.

The penis is situated in front of the pubes, and above the scrotum. When relaxed it is nearly cylindrical in shape, and curved with its concavity presenting downward; but in a state of erection, it is triangular prismatic, with its three angles rounded, and describes a very slight curve in an opposite direction. It is divided into three parts; the root, the body, and the head or glans; and consists essentially of a peculiar erectile tissue, in the form of two semicylindrical bodies (cavernous bodies), and one cylindrical body (spongy body), covered by skin and superficial fascia.

The *skin* of the penis is very thin, and of a brownish hue, but lighter than that of the scrotum. It is attached to the subjacent parts by a loose sero-areolar tissue, and prolonged over the glans or head in the form of a loose hood or sheath, called the foreskin or prepuce, which in many individuals is so long as to conceal this part of the organ entirely, but in others constitutes only a narrow rim surrounding the constriction or neck, immediately back of the head. The interior of the prepuce is lined by a thin mucous membrane, continuous with the skin at the free edge, and connected to it by remarkably loose areolar tissue, which is spread out when the skin is drawn back. From the inner surface of the prepuce the mucous membrane is prolonged upon the neck and head of the penis, in a still more attenuated form, and at the external orifice of the urethra is continuous with the lining membrane of this canal. Beneath the

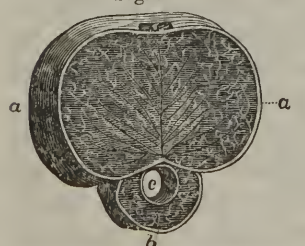
mouth of the urethra it forms a vertical triangular fold, called the *bridle of the prepuce* (*frænum præputii*). In the substance of the mucous membrane behind the prominent border or *crown* (corona) of the glans, are quite a number of sebaceous glands or follicles, which secrete the offensively odorous white matter, that collects in this situation in persons of uncleanly habits.

The *subcutaneous areolar tissue*, or superficial fascia of the penis, is remarkably loose and open, and, like that of the eyelids and some other parts of the body, is never the seat of adipose development. It envelops the organ entirely as far forward as the head, and upon the upper surface of the root is collected into a large, loose, open band, called the *suspensory ligament* of the penis, which extends up the middle line of the anterior abdominal wall half way to the umbilicus.

Dissection.—Cut down upon the deep dorsal vein that lies in the groove between the two cavernous bodies upon the upper surface of the penis near the pubes, insert a blowpipe, and inflate the spongy body. If the valves of the vein prevent the passage of the air, they may be broken down with a probe or a stout broom-straw introduced from behind forward. Inflate also the cavernous bodies, the blowpipe being introduced into the root of the right, which has been already detached from its connection with the corresponding ischium. If convenient, however, it is much better to use some solid injection, such as wax or tallow. Next, dissect off the skin and superficial veins, so as to expose the cavernous and spongy structures.

The cavernous bodies (*corpora cavernosa*) (Fig. 164) are two semicylindrical bodies joined together by their flat surfaces, and extending from the pubes to the glans of the penis. Posteriorly, they are attached, as seen in the dissection of the perineum, to the inner edge of the ascending branches of the ischium, by two diverging legs or crura, which unite with each other about half an inch in front of the highest point of the arch of the pubis, and become, as it were, one body flattened from above downward, and grooved in the median line upon its superior and inferior surface. The superior groove is occupied by the superficial and deep veins, and dorsal arteries of the penis, and the inferior, by the spongy body. The anterior extremities of the two bodies are slightly rounded, and closely connected to the base of the glans, with whose interior, however, they have no communication.

Fig. 164.



Transverse section of the penis. *a*, *a*. The cavernous bodies. *b*. Spongy body. *c*. Urethra.

Structure. — The cavernous bodies

consist of a fibrous wall or coat, and an internal cavernous or erectile tissue. The *fibrous coat* forms a common investment for the two bodies; it is thick and strong, highly elastic up to a certain point, and composed of white tendinous-looking fibres that cross each other in every direction.

The *cavernous tissue* consists: 1, of fibrous bands, technically called *trabeculæ*, crossing each other in every direction so as to inclose tolerably large interspaces; 2, of a nervous plexus filling these interspaces; and, 3, of arterial twigs ramifying within the substance of the trabeculæ, and upon them. Examined upon a transverse section (Fig. 164), the two bodies are found to be separated by a median vertical plate of fibrous structure, which is thick and complete behind, but farther forward thin and open, and consists only of vertical bands separated by slits of various sizes for the free communication between the bodies; on account of this comb-like appearance, it is called the *pectiniform septum.*

1. The fibrous bands or *trabeculæ* are prolongations of the fibrous envelop. They vary in their shape and size, being in some places lamellar, in others cord-like, and in others mere threads, and cross each other in every direction and inclose irregular interstices, which communicate freely with one another in the same body, and with those of the opposite body through the slits of the pectiniform septum. 2. The *intertrabecular spaces* may be considered either as occupied by a venous plexus, or as forming so many divisions of a large cavernous sinus, lined by a continuation of the internal tunic of the veins supported by the fibrous bands. The veins with which they communicate pass out, for the most part, near the root of the penis, to join the large plexus around the prostate gland and base of the bladder, but quite a number emerge also by the side of the spongy body, and, winding around the sides, open into the dorsal veins of the penis. 3. The *arteries* of the cavernous bodies consist of two small branches of the internal pudics that enter the roots of these organs, and of offsets from the two dorsal arteries of the penis that run along the groove upon the upper surface. The twigs given off from these branches ramify throughout the cavernous structure in the substance of the fibrous bands and cords, subdivide very minutely, and, having become capillary, terminate in the veins occupying the intertrabecular spaces. The exact disposition of these vessels, however, before they terminate in the veins, is not certainly known, although the description given by Müller seems most probable. According to this observer, the smallest ramifications of the arterial

twigs, which he calls the "helicine arteries," leave the sides of the trabeculæ, project into the venous cavities covered by the lining membrane, and open by dilated extremities, some of which he describes as single, and some as forming tufts composed of minute subdivisions of a single projecting twig.

The SPONGY BODY (*corpus spongiosum*) (Fig. 159) occupies the inferior groove formed by the union of the two cavernous bodies, and is expanded over the anterior extremities of these organs to form the large head called the glans of the penis. Behind the glans, it is nearly cylindrical in shape and much smaller than the cavernous bodies, but at its posterior extremity it swells out to a considerable size, constituting, as already mentioned, the *bulb* of the penis. The bulb is situated beneath the triangular space formed by the divergence of the legs (crura) of the cavernous bodies, rests against the anterior surface of the middle layer of the perineal fascia, and is covered by the compressor or accelerator muscle. The anterior extremity, named *head* or *glans* of the penis, is conical in shape; its base presents backward and in close connection with the anterior extremities of the cavernous bodies, its free surface invested by mucous membrane and partially covered by the prepuce, and its rounded apex perforated by the external slit-like orifice of the urethra. The base of the head is cut, as it were, obliquely from above downward and forward, and, its circumference being greater than that of the cavernous bodies, forms a projecting ridge called the *crown* (corona), behind which is a kind of groove or neck interrupted in the middle line below by the bridle of the prepuce.

The spongy body is traversed its whole length, from the bulb to the apex of the glans, by the canal of the urethra, as will be hereafter more particularly described.

STRUCTURE.—The spongy body is only a modification of the structure of the cavernous, the difference consisting in the greater thinness of its fibrous envelop, the finer quality of its trabeculæ or bands, and the smaller size of its intertrabecular spaces. It has no communication with the cavernous bodies, and its veins terminate principally in the deep dorsal veins of the penis, a few smaller branches leaving the bulb to join the plexus around the prostate gland. Its arteries are: 1, the *arteries of the bulb*, one on each side, which leave the internal pudic in the triangular space between the anterior and posterior layers of the deep perineal fascia, enter the organ along with the membranous portion of the urethra, and are distributed nearly as far as the head; 2, the *dorsal arteries of the penis*, the two ter-

minal branches of the internal pudics, which ascend through the triangular space formed by the divergence of the posterior extremities of the cavernous bodies, run along the sides of the groove upon the dorsal surface of the penis, sending twigs to the subjacent parts, and, having reached the neck of the organ, divide into several branches which enter the base of the head and ramify in its fine intertrabecular spaces.

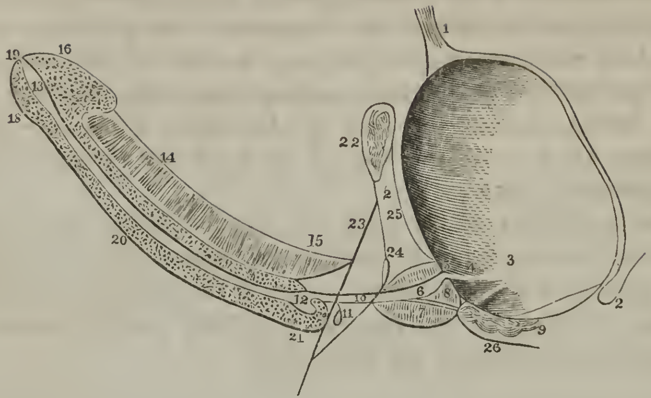
The *lymphatics* of the penis are very numerous; they form an intricate network over the head of the organ and in the prepuce, and, passing backward upon the surface of the cavernous and spongy bodies, terminate in the inguinal lymphatic glands situated just above the inner third of the crural arch.

THE URETHRA IN THE MALE.

The urethra, the excretory duct of the urine and spermatic fluid, extends from the neck of the bladder to the opening upon the head of the penis, and in the flaccid state of this organ describes a double curve. The posterior division of the curve is short and permanent; it commences at the neck of the bladder and ends beneath the pubes, and presents its concavity upward and forward; the anterior is much longer, and looks downward and backward; but when the organ is in a state of erection, it is straightened out, or even bent slightly in an opposite direction. The length of the canal depends very much upon the state of the penis, and upon the manner in which the measurement is made. The average may be stated at eight or nine inches. Its diameter varies at different points, and cannot be accurately ascertained on account of the extensibility of its walls, but it is sufficient to state that a catheter, a quarter of an inch (three lines) in diameter, readily passes the whole length of the canal in the adult, and that, by a process of gradual dilatation, it may be made to accommodate, without injury or inconvenience, an instrument twice the size. It is divided into a *prostatic*, *membranous*, and *spongy* portion.

The PROSTATIC PORTION (Fig. 165, 6) traverses the prostate gland from its base to its apex, somewhat nearer the upper than the lower surface of the gland. It is about an inch and a sixth (fourteen lines) in length, triangular prismatic rather than cylindrical in shape, wider at its middle than at either extremity, and, although surrounded on all sides by firm glandular substance, is the most

Fig. 165.



Section of the bladder and penis. 1. Urachus. 2. Vesico-rectal reflection of the peritoneum. 3. Opening of the right ureter. 4. Slight ridge leading to the neck of the bladder. 5. Commencement of the urethra. 6. Prostatic portion of the urethra. 7, 8. Prostate gland; between these two figures is seen the right ejaculatory duct. 9. Right seminal vesicle. 10. Membranous portion of the urethra. 11. Cowper's gland. 12. Bulbous portion of the urethra. 13. Navicular fossa. 14. Right cavernous body. 15. Root of the same. 16. Head of the penis. 18. Lower segment of the same. 19. External meatus. 20. Spongy body. 21. Bulb of the spongy body. 22. Section of the pubic symphysis. 23. Cut edge of the deep perineal fascia. 24. Posterior layer of the deep perineal fascia. 25, 26. Pelvic fascia.

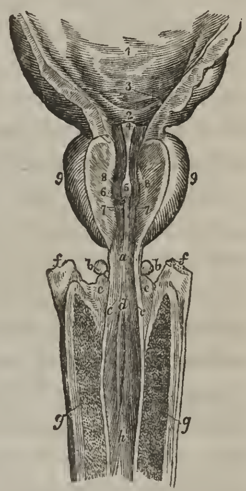
dilatable part of the canal. Its direction corresponds to that of the axis of the prostate, which is forward and somewhat downward. When laid open, its lining mucous membrane will be found thrown into several longitudinal folds, all temporary, however, with the exception of the largest one, which froms a prominent ridge (Fig. 166, 5) along the floor of the passage, and is called the *urethral* or *gallinaginous crest* (*caput gallinaginis*, also *veru montanum*). This is from seven to nine lines in length, about a line and a half in height at its highest point, and presents near its anterior extremity a little depression or pit called the *pocular** *sinus*, upon the sides of which may be seen two minute foramina, the orifices of the ejaculatory ducts. By means of this crest, the floor of the prostatic urethra is divided into two longitudinal depressions or grooves, named the *prostatic sinuses*, in which the numerous ducts of the prostate gland terminate by small circular mouths.

The MEMBRANOUS PORTION (Fig. 165, 10), the narrowest part of the canal except the external orifice, extends, in the middle line of the perineum, from the apex of the prostate gland to the superior surface of the bulb of the spongy body. It is directed forward and

* *Poculum*, a cup.

very slightly upward, lies about one inch below the lower edge of the pubic symphysis, and traverses in its course, first, the posterior layer of the deep perineal fascia (24), then the narrow space between this and the anterior layer, and, lastly, just before terminating in the bulb, the anterior layer (23), called also, as frequently before mentioned, the triangular ligament of the urethra. Its superior surface is slightly concave, and measures about ten lines in length, but its inferior, owing to the oblique manner in which the anterior extremity terminates in the bulb, is three or four lines less. It is covered by a continuation of the anterior and posterior layers of the perineal fascia, inclosed by the union of the transverse and vertical fibres of the compressor muscle and surrounded by an intricate plexus of veins, which separates it above and upon each side from the arch of the pubis, and below from the posterior or upper surface of the triangular ligament, and the other parts that fill up the pyramidal space between it and the rectum, as already seen in the dissection of the perineum. It is in the narrow space between the anterior and posterior layers of the deep perineal fascia, that the canal is first reached in the lateral operation of lithotomy, the incision being then extended from the middle of this portion obliquely backwards into the prostatic portion, by dividing the left lobe of the gland to about one-half or two-thirds its extent.

Fig. 166.



The prostatic, membranous, and part of the spongy portion of the urethra, with part of the bladder. 1. Internal surface of the bladder. 2. Vesical trigone 3. Openings of the ureters. 4. Vesical uvula. 5. Urethral or gallinaginous crest. 6. Opening of the poeular sinus. 7, 7. Openings of the ejaculatory ducts. 8, 8. Openings of the prostatic ducts. The numbers 7, 7, and 8, 8, are placed on the cut surface of the supra-urethral portion of the prostate gland. 9, 9. Lateral lobes of the prostate gland. *a.* Membranous portion of the urethra. *b*, *b*. Cowper's glands. *c*, *c*. Mouths of the ducts of the same. *d*. Commencement of the spongy portion of the urethra. *e*, *e*. Upper surface of the bulb. *f*, *f*. Roots of the cavernous bodies. *g*, *g*. Cavernous bodies. *h*. Spongy portion of the urethra.

The SPONGY PORTION commences in the centre of the bulb by a somewhat dilated fluid extremity called the *sinus of the bulb* (12), passes forward through the axis of the spongy body and terminates upon the head of the organ in a vertical slit-like orifice commonly called the *external meatus* of the urethra. Its direction is generally curved with its concavity directed downward, but varies with the

position and state of the penis. Its average length is from six to seven inches. Its diameter differs at different points; thus, in the bulb there is a slight dilatation, immediately in front of this a slight contraction, then a uniform size as far as the glans, in which there is a considerable dilatation called the *navicular fossa*, and again immediately at the external meatus another contraction greater than at any other point in the whole canal. The communication of the spongy with the membranous portion of the urethra takes place about the fourth or sixth of an inch in front of the posterior extremity of the former, upon its upper wall. The portion behind this constitutes the sinus of the bulb, which is, therefore, a sort of diverticulum from the main canal.

Structure.—The interior of the urethra is lined by a mucous membrane continuous with that of the bladder, prostatic, ejaculatory, and Cowper's ducts, and with the covering of the glans. It is of a light pinkish color, thin and weak, and, in consequence of the loose nature of the subjacent areolar tissue, is thrown into numerous longitudinal folds, which, however, are only temporary, being effaced by the passage of urine. It has imbedded in its substance numerous mucous follicles whose mouths look obliquely forward; one of them, situated upon the upper wall of the navicular fossa, is called, from its very large size, the *lacuna magna*. The orifices of the ducts of Cowper's glands are situated just in front of the sinus of the bulb, and are very small. External to the mucous lining, in the spongy portion of the urethra, is a layer of soft reddish-looking tissue, whose fibres run longitudinally and extend nearly from one end to the other; but the precise nature of these fibres has not been positively determined. Circular fibres are also said, by some authors, to exist in this situation, forming a layer internal, and another external to the longitudinal fibres.

The membranous portion is provided with muscular fibres in the form of a distinct muscle, already described.

Introduction of the Catheter.—Although a great many natural obstacles to the passage of the catheter into the bladder are enumerated in the various works on surgery, there is, anatomically considered, but one of any great importance. This is formed conjointly by the sinus of the bulb and the deep perineal fascia or triangular ligament. It is true, that if an instrument not larger than a common knitting-needle or probe is used, it may be caught in the open mouths of some of the mucous follicles, particularly the large one upon the upper wall of the navicular fossa, or in the orifices of the ducts of Cowper's glands, if they should happen to be very large, which is but rarely if ever the case, or possibly in the pocular sinus of the gallinaginous crest; or if a straight metallic instrument were employed, there might be

some difficulty arising from the permanent nature of the first or smaller curvature of the canal, although even this with proper skill may be readily overcome. But with a metallic instrument, two or three lines in diameter, possessing the ordinary curve near its distal extremity, the only serious obstacle arising from the conformation of the parts is the one above mentioned (spasmodic contraction of the canal being, of course, excepted), and this is to be overcome by following the usual directions of practical surgeons. Thus, the patient lying near the left edge of the bed on his back, with the legs and thighs flexed, and the latter separated, the operator holds the catheter near the extremity of its handle lightly between the thumb and first two fingers of his right hand, while with the left he raises the penis to a vertical line and puts it very slightly on the stretch, the handle being held parallel with and very near the abdomen in the median line. The point of the instrument is then introduced into the external orifice of the urethra, and carried down until it stops, the hand remaining in the same position. If there is no unnatural obstruction, the point will not be arrested until it reaches the bulb, which, when pressure is made, is forced against the triangular ligament or deep perineal fascia, and gives that feeling to the hand as if the instrument had reached the bottom of a resisting cavity. In order now to disengage the point from the sinus of the bulb, and to lodge it in the membranous portion of the canal, which, it will be remembered, opens upon the superior wall of the spongy portion just in front of the sinus, the handle is raised from the horizontal to a vertical line, and, if necessary, depressed between the thighs, at the same time that very gentle pressure is made in the natural direction. Having once entered the membranous urethra, the instrument passes inward to the bladder without difficulty.

The common mistake that students and inexperienced physicians make, is to raise the handle from its horizontal position too soon, before the point reaches the sinus. But even when the above directions are fully carried out, difficulty is often experienced in getting the point into the membranous urethra, arising from causes that cannot always be explained, which, however, may be invariably overcome by gentle repetition of the trial and the exercise of a little patience.

THE TESTICLES AND THEIR EXCRETORY APPARATUS.

The two testicles are suspended beneath the root of the penis by the spermatic cords, and inclosed by the scrotum and a serous membrane called the vaginal tunic or sac.

The SCROTUM is a musculo-cutaneous bag, placed below the root of the penis to contain the testicles and the lower extremities of the spermatic cords. Its size differs in different individuals, and in the same person under different circumstances. It is contracted or drawn into a small firm ball under the influence of cold and certain states of the mind, and long and pendulous, when relaxed by heat or other depressing causes. Its external or cutaneous layer is of a dusky brown color, very thin, set with long scattered hairs, traversed from

before backward by a well marked median line or *raphé*,* continuous with that of the perineum, and, in the contracted state of the organ, folded on each side into numerous small wrinkles, most of which run transversely. Beneath the skin is the *dartos*† layer, a kind of musculo-areolar tissue, loose in its texture, of a reddish color, and very vascular. It is continuous with the superficial fascia of the perineum, attached on each side to the ramus of the ischium, and in front, to the under surface of the back part of the penis. Its interior is divided into two lateral compartments by a middle wall or septum of the same tissue, and is loosely connected to the contained organs. Its external surface is closely connected to the skin, which being very thin, allows the numerous veins that ramify in its substance to be seen through it. Its fibres cross each other in every direction and are said to belong to the class of involuntary or unstriped muscle. By its contraction, which is independent of that of the cremaster muscle, the testicles are slightly compressed and drawn up toward the groins.

Within the dartos is a layer of loose open areolar tissue, continuous with the spermatic or intercolumnar fascia of the spermatic cord. Next within this are the pale scattered fibres of the cremaster muscle, which, coming from the crural arch in connection with the lowermost fibres of the internal oblique muscle of the abdomen, descend upon the outer side of the cord, and, forming loops around the vaginal tunic, return to be inserted into the body of the pubic bone.

Removing the fibres of the cremaster muscle, which constitutes what is technically called the *tunica erythröides* of the testicle, and dissecting off a thin layer of fascia continuous with the tubular or transverse fascia of the cord, the vaginal tunic will be brought into view.

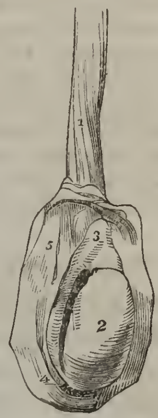
The VAGINAL TUNIC OF THE TESTICLE is a serous sac, which lines the interior of each lateral half of the scrotum, and invests the contained organ. Its *parietal layer* is covered by a continuation of the tubular or transverse fascia of the spermatic cord and the scattered fascicles of the cremaster muscle, and connected to the internal surface of the dartos by loose areolar tissue continuous with the spermatic or intercolumnar fascia of the cord. The *visceral layer*

* From the Greek ῥάπτω, to sew, because it resembles a seam.

† The etymology of this word is uncertain; it may come from the French *dartre*, tetter, or the Greek δέρω, raw, from its raw, excoriated appearance.

invests the lower extremity of the spermatic cord and the whole of the body of the testicle, except a narrow space along the posterior border of the organ where the vessels enter and emerge. It is pushed in, as it were, between the middle of the epididymis and the body of the gland, in the form of a little pouch on each side, and covers the lateral surfaces of the epididymis, and, at the posterior border of the latter, is continuous with the parietal or reflected layer. The connection between the visceral layer and the fibrous or proper coat of the body of the testicle, is by close, strong, areolar tissue.

Fig. 167.



The testicle, and part of the spermatic cord, with the tunica vaginalis laid open. 1. Lower part of the spermatic cord. 2. Body of the testicle. 3, 4. The epididymis. 3. Globus major or head. 4. Globus minor or tail. 5. Internal surface of scrotal portion of vaginal tunic.

The internal surface of the vaginal tunic is smooth and polished, always in contact with itself, and exhales, for the purpose of lubrication, a very small quantity of thin serous fluid, which, when unnaturally copious, constitutes the disease called *hydrocele*.

Vessels and Nerves of the Scrotum.—The *arteries* that supply the scrotum are the two external pudics, a branch from the superficial perineal, and several small twigs from the cremasteric. The *external pudics*, quite small, are branches of the femoral artery, which they leave at the saphenous opening, and, passing transversely across the lowest part of the groin, supply the skin and dartos of the anterior part of the scrotum. The *superficial perineal* is a branch of the internal pudic, and, after supplying the skin of the perineum, is distributed to the back part of the scrotum. The *cremasteric* is a small offset from the epigastric; it descends upon the spermatic cord to supply the cremaster muscle, and sends minute twigs to the dartos and skin of the scrotum. The *veins* follow the course of the arteries. The *lymphatics* are few and scattered, and terminate in the glands of the groin. The *nerves* are: 1, the scrotal branch of the ilio-lumbar (a branch of the lumbar plexus), which passes out at the external abdominal ring and is distributed to the skin of the scrotum; 2, branches from the two superficial perineal nerves, derived from the internal pudic; 3, the inferior pudendal, a slender twig from the small sciatic that joins the preceding; and, 4, the genital branch of the genito-crural, which leaves the abdomen through the inguinal canal, and,

having supplied the cremaster muscle, sends filaments to the vaginal tunic and its coverings.

The vaginal sac is originally derived from the peritoneum, being a mere prolongation of the latter membrane, generally described as carried down through the inguinal canal into the scrotum by the testis. A narrow, tubular communication, therefore, exists between the two immediately after the testicle reaches its place, but within a few days the serous tube is obliterated or converted into a fibro-areolar cord, and the vaginal tunic is then an independent sac. Occasionally, a coil of intestine follows close after the testis in its descent, thus preventing the closure of the tube, and constitutes what is known as congenital hernia, the vaginal tunic, in this case, being substituted for the proper hernial sac. Not unfrequently, the fibrous band into which the tube is converted may be found in the adult lying in front of the spermatic vessels, covered by the intercolumnar fascia, cremaster muscle, and tubular fascia, and attached to the upper extremity of the vaginal sac.

The TESTICLES, the two glands that secrete the spermatic or seminal fluid, hang suspended in the cavity of the scrotum by the spermatic cords, but not upon the same level, the left being a little the lower. Their number seldom varies, although they are not always found in the scrotum. Sometimes one or the other, or occasionally both, remain in the abdomen or in the inguinal canal, and in one instance that came under my observation, the left was situated between the external and internal oblique muscles of the abdomen, about two inches above the crural arch, having gained this position by passing down the inguinal gland, and then turning upward instead of going out of the external ring. They are oval, but slightly flattened in a lateral direction, and are connected to the spermatic cord in such a manner, that their long axes are directed from above downward and backward. They generally measure nearly an inch and a half in length, three-quarters in thickness, and an inch from the anterior to the posterior border. Their weight varies from four to eight drachms each.

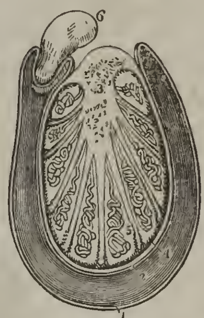
STRUCTURE.—The structures composing each testicle are a fibrous envelop, called the albugineous coat, a proper or tubular tissue, and several vessels and nerves.

The *albugineous* or *fibrous coat* forms a complete envelop for the organ, is of a bluish-white color, dense and unyielding, and consists of fascicles of white glistening fibres, closely interlacing each other in every direction. It is invested *externally* by the visceral layer of the vaginal sac, except along the posterior border, where it is perforated by the vessels and nerves, and by the ducts that leave the organ at this point to form an elongated mass called the epi-

didymis. From its *internal surface*, opposite the upper part of the posterior border, it sends a short, flattened process downward and forward, which forms an imperfect median septum or partition, called the *mediastinum*, or the *body of Highmore* (*corpus Highmorianum*). This septum is perforated by the bloodvessels and ducts, and from its border and lateral surfaces, numerous fibrous cords or columns (*tuberculæ*) pass to all points of the inner surface, and divide the inclosed space into as many separate compartments for the protection of the tubular tissue of the gland.

Lining the internal surface of the albugineous tunics, and the several compartments formed by the fibrous threads, is an exceedingly delicate network of arteries and veins, held together by fine areolar tissue, and described by Sir Astley Cooper, its discoverer, as the *vascular tunic* (Fig. 168, 4) (*tunica vasculosa*).

Fig. 168.



A transverse section of the testicle 1. The cavity of the vaginal tunic. 2. The albugineous tunic. 3. The mediastinum giving off numerous fibrous cords in a radiated direction to the internal surface of the albugineous tunic. The cut extremities of the vessels below the number belong to the rete, and those above to the arteries and veins of the organ. 4. The vascular tunic. 5. One of the lobules, consisting of the convolutions of the seminiferous tubules, and terminating by a single duct. Corresponding lobules are seen between the other fibrous cords of the mediastiuum. 6. Section of the epididymis.

The *tubular* or *proper tissue* of the testicle occupies the cavities formed by the fibrous prolongations of the mediastinum or body of Highmore, by which it is divided into many small masses called *lobules.* The lobules (Fig. 169, 1, 1) are conoidal in shape, and have their apices directed toward the posterior border of the organ, and their bases towards its circumference. The number of these lobules or cones is variously stated by authors at from 250 to 400. Their size corresponds to that of the cavities in which they are contained, those running antero-posteriorly being consequently the longest. Each lobule consists of one or two minute tubules (*seminiferous tubules*) each coiled upon itself a great many times, and connected to the surrounding parts by vessels from the vascular tunic, and by a small quantity of delicate areolar tissue. The length of each tubule, when unravelled, is nearly sixteen feet, and of all of them together, according to Monro, about five thousand feet, or little more than a mile. Their diameter is about $\frac{1}{200}$ of an inch.

The seminiferous tubules commence either in blind extremities or

loops, and, having become coiled up as above mentioned, leave the apices of the cones or lobules behind in a straight direction, and enter the body of Highmore, where they become again somewhat convoluted, constituting what is termed the *tubular rete* (2). In this network, which is situated along the posterior border of the organ within the albugineous coat, the tubes unite with one another to form about thirty common ducts called the *efferent ducts*, which perforate this tunic and its upper back part, and, becoming coiled upon themselves, once more constitute a permanent mass, named the head of the epididymis (5, 5).

The *epididymis** (Fig. 169, 5, 6) is a permanent, elongated body, flattened from side to side, situated along the posterior border of the body of the testicle, and covered upon its lateral surface by the visceral layer of the vaginal sac. Its superior extremity, called the *head* or *greater globe* (*globus major*), rises from the superior part of the posterior border of the testicle, becomes somewhat expanded,

Fig. 169.

Testicle injected with mercury and divested of its albugineous tunic. 1, 1. Lobules formed by the seminiferous tubules. 2. Tubular rete. 3, 4. Vascular cones formed by the seminiferous tubes. 5, 6. Epididymis. 7. Aberrent duct. 8. Termination of the epididymis in 9, 9, the deferential tube.

and when viewed laterally looks a little like the crest of an ancient helmet. Below the head, it is contracted and narrow, and separated

* From ἐπι, upon, and διδυμος, the testicle.

form the testicle by a prolongation of the vaginal tunic; but at the lower extremity (the *smaller globe* or *tail*) it becomes again enlarged, but not to the same size as above, is attached to the lower part of the posterior border of the gland by the vaginal tunic, and descends a short distance below its lower extremity, to become continuous with the seminal or deferential tube.

STRUCTURE.—Beneath the vaginal tunic that invests the lateral surfaces of the epididymis, is an exceedingly thin fibrous expansion continuous with the albugineous tunic. The proper tissue of the epididymis, inclosed by this expansion, is essentially the same as that of the body of the testicle, and is arranged in the following manner: The ducts derived from the tubular rete, fifteen or twenty in number, and about $\frac{1}{80}$ of an inch in diameter, all perforate the albugineous coat upon the upper back part of the testicle, then diverge from one another, and become separately coiled into as many little tubular cones (3, 4) (*coni vasculosi*), from six to eight lines in length, the bases of which form the free border of the greater globe. Along this border the tubes from the several cones successively unite, from above downward, to form a single duct called the *canal of the epididymis*, which, becoming many times coiled upon itself, constitutes the remaining part of the epididymis. From the lower extremity of the tail or smaller globe, the canal is unravelled, turns upward, and, ascending along the posterior border of the organ, takes the name of the seminal duct or deferential tube (*vas deferens*). The length of each tube composing the cones of the greater globe is six or eight inches; their diameter, however, gradually decreases from the time they leave the testicle, and the common duct or canal of the epididymis, which they unite to form, is but little larger than the first part of one of these efferential ducts. The length of this canal, when uncoiled, is over twenty feet; its diameter, at first about $\frac{1}{70}$ of an inch, becomes even less in the tail of the epididymis, but again enlarges toward the commencement of the deferential tube.

The walls of the seminiferous tubules and efferential ducts consist of two coats, an *external*, of a grayish semi-transparent appearance, possessed of considerable strength and elasticity, and composed of fibro-elastic tissue; and an *internal*, a delicate mucous membrane, with a squamous epithelium, whose cells contain a granular substance, and are supposed to secrete the seminal fluid.

The DEFERENTIAL TUBE (*vas deferens*, seminal duct) is the con-

tinuation of the canal of the epididymis. Commencing at the tail of the epididymis, it makes a short turn and ascends in a serpentine manner along the posterior border of the organ, but is separated from it by the bloodvessels of the testicle. Opposite the greater globe it becomes straight, enters the spermatic cord, and ascends in connection with the spermatic artery and veins to the external abdominal ring, and through the inguinal canal; at the internal ring it leaves the spermatic vessels, turns suddenly downward and inward beneath the peritoneum and around the epigastric artery, crosses the external iliac vessels, and having gained the side of the bladder, curves over toward the base of this organ, which it reaches upon the inner side of the entrance of the ureter. At the base of the bladder it is directed forward and inward along the inner side of the corresponding seminal vesicle, approaching its fellow of the opposite side, and having nearly reached the base of the prostate gland, unites with the duct from the vesicle to form the common seminal or ejaculatory duct (Fig. 162, 7), which perforates the prostate, and opens separately by a minute orifice upon the side of the little recess called the pocular sinus, formed upon the summit of the urethral or gallinaginous crest.

It is cylindrical, and so firm and hard that it may be easily felt through the skin, and separated from the other constituents of the spermatic cord. Its length is nearly two feet, and its diameter not more than $\frac{1}{10}$ of an inch, except two inches of its terminal extremity, which is slightly enlarged. The diameter of its canal is not more than one-fourth of a line, but its walls are dense and strong, and about one-third of a line thick, except at the dilated part, where they are thinner, and the canal correspondingly larger.

The deferential tube is covered externally by a thin cellular sheath, but its great thickness and strength are due to the subjacent coat, which is dense and firm, of a grayish yellow color, and composed of fibres which are mostly longitudinal, and similar to those of ordinary yellow elastic tissue. Its interior is lined by a delicate mucous membrane, of a pale color, marked by numerous fine longitudinal ridges, and covered by a columnar epithelium. In the dilated portion there are, in addition to the longitudinal ridges, transverse folds which give to the surface a sacculated appearance.

The *aberrant duct* (*vas aberrans*) (Fig. 169, 7) is a narrow blind tube about three inches long, situated among the structures of the lower part of the spermatic cord, and extending in a tortuous manner along the posterior border of the epididymis to the commencement

of the deferential tube. Its superior extremity is closed, but below it communicates with the canal of the deferential tube, of which, in fact, it is a mere diverticulum. It is frequently wanting.

The SEMINAL VESICLES (*vesiculæ seminales*) (Fig. 162) are two oblong membranous reservoirs of the seminal fluid. They are situated upon the under surface of the base of the bladder, and extend from near the terminations of the ureters, along the outer boundaries of the vesical trigone of the prostate gland. They are about two inches long, half an inch broad, and separated from each other about two inches at their posterior extremities; but they converge from behind forward, and terminate anteriorly in a small duct, which joins the deferential tube to form the ejaculatory or common seminal duct. They are closely connected to the bladder by a reflection of the pelvic fascia, and are in relation behind with the anterior surface of the rectum. The deferential tubes pass along their inner border.

When the fibrous covering, which the seminal vesicles derive from the pelvic fascia, is removed, they present the appearance of convolutions. These may be dissected apart, and each sac will be then found to consist of a membranous tube four to six inches long, and about a quarter of an inch in diameter, many times folded upon itself, and terminating posteriorly in a blind extremity, near which may sometimes be seen one or more diverticula passing off to the distance of an inch or two, and ending in the same manner.

STRUCTURE.—The structure of the seminal vesicles is similar to that of the deferential tube, but their caliber is much greater, and the lining mucous membrane is marked by numerous delicate ridges, inclosing small interspaces like those found upon the interior of the gall-bladder, but much finer. Its epithelium is squamous.

The *duct* of each seminal vesicle proceeds from the anterior extremity of the organ; it is short and narrow, and joins the deferential tube, near the base of the prostate gland. The *common seminal* or *ejaculatory duct*, formed by this union, enters the back part of the prostate gland, runs forward and upward, approaches its opposite fellow, and the two, lying side by side, open by small separate orifices in the prostatic portion of the urethra, either in the bottom or upon the sides of the little depression (pocular sinus), situated upon the summit of the gallinaginous crest.

VESSELS AND NERVES OF THE TESTICLES, AND THEIR EXCRETORY APPARATUS.—The special *artery* of the testicle is the *spermatic*,

which originates from the abdominal aorta and descends behind the peritoneum to the internal abdominal ring, and then through the inguinal canal, forming one of the constituents of the spermatic cord. Near the testicle it divides into numerous twigs, some of which are distributed to the epididymis, but most of them perforate the albugineous coat along the posterior border of the organ, and form that delicate network called, by Sir A. Cooper, the vascular tunic. From this network minute offsets proceed along the fibrous beams (trabecular) to be distributed to the seminiferous tubules.

The deferential tube is supplied by a very remarkable delicate arterial twig called the *deferential artery*, which comes from the superior vesical, a branch of the internal iliac, and follows the tube from the pelvis as far as the testicle.

The *spermatic veins* leave the testicle and epididymis by the side of the corresponding branches of the spermatic artery, ascend the spermatic cord in a very tortuous manner, and, gradually uniting with one another, form two main trunks, which enter the abdomen through the inguinal passages, and in their turn unite to form a single trunk. The right opens into the ascending cava, and the left into the renal vein of the same side. These veins are very liable to become enlarged and varicose, particularly those of the left side, constituting the disease known as varicocele.

The *lymphatics* of the testicles accompany the spermatic artery and vein, and terminate in the lymphatic glands in the lumbar region of the abdomen.

The *nerves* of the testicle are for the most part branches of the hypogastric plexus, and belong therefore to the sympathetic system, but that it receives filaments from the cerebro-spinal system also, is amply proved by the great pain experienced when the organ is severely pressed or otherwise injured.

The seminal vesicles receive arterial twigs from the vesical arteries, which are accompanied by corresponding veins. Their nerves are derived from the hypogastric plexus.

THE FEMALE ORGANS OF GENERATION*

AND THEIR

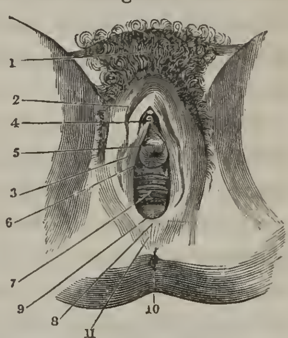
ASSOCIATE STRUCTURES.

The generative organs of the female are commonly divided into external and internal. The *external* comprise a number of parts under the general name of vulva: the *internal* are, the vagina, uterus, Fallopian tubes, and ovaries. The former should first be examined.

DISSECTION.—Draw the subject to the end of the table, flex and separate the lower extremities, and make free use of soap and water.

The term VULVA, in its general acceptation, comprises all the external female organs of generation, seen in an ordinary examination when the thighs are widely separated. Its principal divisions are the mons Veneris, labia, clitoris, nymphæ, and perineum. The *mons Veneris* (Fig. 170), is the rounded eminence situated in front of the pubis, above the genital fissure, and covered in the adult with hair, which is said by a French anatomist to be more curly in married women than in virgins. The elevation is due in part to the projection of the bones at the pubic symphysis, but mainly to a thick layer of subcutaneous adipose substance, remarkable for its density, and intimate

Fig. 170.



The vulva. 1. Mons veneris. 2. Right labium. 3. Right nympha. 4. Clitoris, of which only the anterior extremity is seen. 5. Vestibule. 6. Orifice of the urethra. 7. Commencement of the vagina. 8. Fourchette. 9. Navicular fossa. 10. Anal orifice. 11. Perineum.

* If the subject which the student is engaged in dissecting is a male, he may pass over this section, devoted to the female pelvis and organs of generation, and proceed to the dissection of the vessels and nerves of the pelvic cavity.

attachment to the subjacent parts. The *labia* (*labia majora*) are the two large, rounded folds of integument, that form the margins or *lips* of the genital fissure. They are thick and prominent in front, but become thinner as they pass backward, and unite in front of the perineum by a little crescentic fold, called the *posterior commissure* or the *fourchette*, which is generally lacerated in first parturitions. The outer surface of each lip is formed by integument continuous with that of the thighs, and is covered with hair; the internal is more of a mucous nature, smooth and moist, and in contact with that of the opposite side. Inclosed between the cutaneous and mucous coverings, and forming the internal structure of the labia, is a quantity of firm adipose substance, a few fibres of yellow elastic tissue, and numerous small vessels and nerves. Within the posterior commissure, and in front of the commencement of the vagina, is a smooth surface slightly excavated, named the *navicular fossa*. Upon the inner surface of the labia are two smaller folds, formed of mucous membrane, inclosing a little erectile tissue. These are the *nymphæ* or lesser labia. They commence within the anterior angle of the genital fissure by two little folds, situated one in front of, and the other behind the clitoris, and soon becoming quite broad, and descending backward, they gradually subside or spread out upon the mucous surface of the labia. They vary greatly in size in different individuals, are relatively larger in infants than in adults. In some of the African races, particularly the Hottentots, they are said to attain an enormous magnitude, hanging down in front of the thighs like an apron.

The *clitoris* is a small reddish-looking process, very much like the uvula, situated about half an inch within, and concealed by the anterior junction or commissure of the labia, and inclosed by the two commencing folds of the nymphæ, which sometimes form a partial covering or prepuce for it. It is the homologue of the penis, and consists of two small cavernous bodies placed side by side, and attached to the rami of the pubis by corresponding divergent roots or crura, which are covered by a small muscle called the *erector of the clitoris*. Its internal structure is precisely similar to that of the cavernous bodies of the penis, and possesses some erectile properties. Its external surface is covered by mucous membrane, which is remarkably sensitive. The clitoris, in addition to its cavernous bodies, is said to possess also a structure at its free extremity beneath the mucous membrane, analogous to the glans or head of the penis, except that it is not perforated by the urethra.

About half an inch behind the clitoris, and just in front of the projecting ridge formed by the commencement of the vagina, is the external orifice of the urethra. Its circumference is slightly raised and puckered. It is small, always closed except during micturition, and if a probe is introduced, will be found to lead upward and backward. Upon each side of the opening may be seen a minute foramen, which is the mouth of a small duct, coming from the corresponding gland of Bartholine, hereafter to be examined. The smooth space between the external orifice of the urethra and the clitoris, is called the *vestibule*.

By separating the labia, the entrance to the vagina will be brought into view. It is large, oval in an antero-posterior direction, and, in the virgin, is occupied and partially closed by a delicate crescentic or circular fold of the mucous membrane, called the *hymen*. The development of the hymen differs in different individuals, and is sometimes almost entirely wanting. When present, it is generally weak and easily ruptured, and hence it readily gives way in the first coition, but its original situation is marked by numerous little fungi-like remnants, called *myrtiform caruncles*.

The *perineum* in the female is a pyramidal or wedge-shaped space, situated between the lower extremity of the vagina and the rectum, and occupied principally by areolar tissue, fat, and bloodvessels. Its base (to which alone students are apt to think the name 'perineum' limited) separates the vulva from the vagina, is covered by smooth skin, and measures about an inch in an antero-posterior direction. The term *posterior perineum* is sometimes applied to the space between the anus and coccyx.

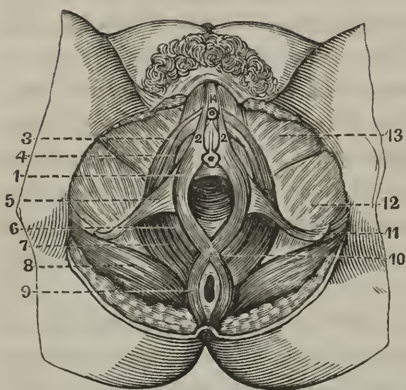
Dissection.—Remove the skin and subjacent adipose substance forming the labia, and from the perineum as far back as the point of the coccyx, and the following muscles will be brought into view.

1. The *sphincter of the vagina* (Fig. 171, 1, 2, 6), is an elliptical muscle surrounding the commencement of the vagina, and consists of two lateral halves, which unite *behind* in the median raphé of the perineum, and *in front*, upon the sides of the clitoris and lower part of the pubic symphysis.

Use.—To close the entrance of the vagina.

2. The transverse perineal muscle (5), small and indistinct, arises on each side from the corresponding ramus of the ischium, and is inserted into the side of the sphincter of the vagina.

Fig. 171.



Muscles of the female perineum. 1, 2, 6. Sphincter of the vagina. 3, 4. Erector of the clitoris (ischio-cavernous). 5, 11. Transverse perineal muscle. 7. Elevator of the anus. 8. Edge of the great gluteal muscle. 10. Junction of the vaginal and anal sphincters.

3. The SPHINCTER OF THE ANUS is not unlike the sphincter of the vagina, only smaller, and precisely similar to the corresponding muscle in the male. It is elliptical, and consists of two lateral halves, which are continuous in front with the posterior extremity of the sphincter of the vagina, and attached behind to the point of the coccyx.

USE.—To close the anus.

DISSECTION.—Remove the two sphincters, and the transverse perineal muscles, and the lower surface of the elevator muscle of the anus, and the erectile tissue of the vagina, called the bulbs of the vagina, will be brought into view.

The ELEVATOR MUSCLE OF THE ANUS is like that found in the male, except that, besides being inserted into the side of the lower extremity of the rectum, it is also inserted into the side of the commencement of the vagina.

The BULBS OF THE VAGINA (*bulbi vestibuli*), are two elongated oval-shaped bodies about an inch in length, consisting of a network of veins inclosed in a fibrous envelop, and situated one on each side of the commencement of the vagina. They are each attached above by a pointed extremity to the corresponding root of the clitoris and ramus of the pubis, covered internally by the mucous membrane lining the sides of the vulva behind the nympha, and embraced externally by the sphincter of the vagina. They are considered as analogous to the bulbous portion of the penis, and communicate with nearly all the surrounding veins, especially the vaginal plexus, and dorsal vein of the clitoris.

The *glands of Bartholine* are two reddish-looking bodies about the size of a small bean, situated one upon each side of the commencement of the vagina behind the superior extremities of its bulbs, and between the mucous membrane and ischio-cavernous muscles of the clitoris (*erectores clitoridis*). They are analogous to Cowper's glands in the male, and each is provided with a long narrow duct,

that opens behind the upper extremity of the nymphæ near the orifice of the urethra.

VESSELS AND NERVES OF THE VULVA.—The mons veneris and labia are supplied with blood by the two *external pudic arteries*, which come from the femoral just below the crural arch. The deeper parts receive branches from the internal pudic on each side. The *veins* are very numerous, and constitute upon the sides of the commencement of the vagina the two erectile masses or bulbs just described, which, with a comparatively large trunk upon the anterior surface of the clitoris, called the dorsal vein of this organ, pass backward to the vaginal plexuses, and ultimately terminate in the internal iliac veins. The obturator vein collects the blood by numerous anastomosing branches from the mons veneris and labia, and passing backward and outward through the obturator foramen, terminates in the internal iliac. The *nerves* of the vulva are branches of the hypogastric plexus which accompany the bloodvessels. It also receives filaments from the genito-crural and fourth lumbar nerve, which is distributed to the mons veneris and labia, and from the internal pudic, which last is said to send a considerable branch to the clitoris. The *lymphatics* accompany the vessels and terminate in inguinal and lumbar glands.

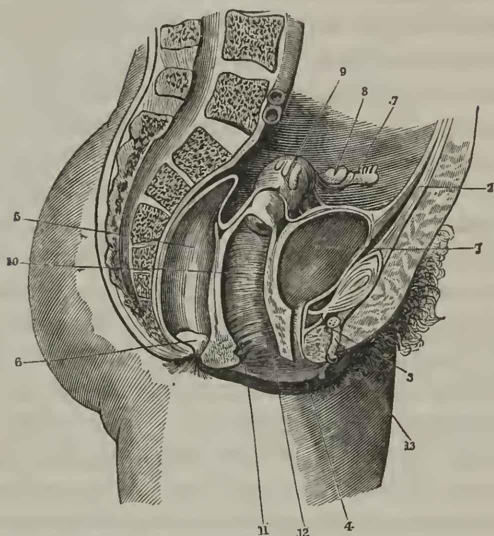
DISSECTION.—Dissect the soft parts from their connections with ramus of the ischium and the pubis of the right side, cut through the pubic symphysis, detach the organs of the pelvis from the right wall of this cavity and push them over to the left; next, divide the right common iliac vessels, sacral plexus of nerves, pyriform muscle, and corresponding sacro-ischiatic ligament, and by forcibly separating the thighs, tear the right ilium from the sacrum. The object of this procedure is to get a profile view of the pelvic organs, which are thus left in the concavity formed by the sacrum and left innominate bone.

Trim the loose ends of the muscles, skin, and other structures from the side of the section, and, having sponged the parts, examine the disposition of the pelvic portion of the peritoneum.

The PERITONEUM (Fig. 172) descends from the posterior wall of the abdomen, upon the front and sides of the rectum, to within three or four inches of the anus, is then reflected forward to the back part of the vagina, the upper third of which it covers, and thence ascends upon the corresponding surface of the neck and body of the uterus. From the fundus of the uterus it is continued down upon its anterior surface as low as the neck; here it passes forward to the bladder, the posterior surface and summit of which it invests, and reaches the anterior wall of the abdomen just above the pubis.

From the sides of the uterus, it is reflected off to the lateral walls of the pelvis in the form of two large vertical folds, called the *broad*

Fig. 172.



Left half of a vertical section of the female pelvis with the rectum, vagina, and bladder laid open, and the uterus turned to the left side. 1. Bladder. 2. Urachus. 3. Anterior ligament of the bladder. 4. Urethra. 5. Rectum. 6. Transverse folds or pouches of the rectum. 7. Left Fallopian tube. 8. Left ovary. 9. Uterus. 10. Vagina. 11 and 12. Anterior and posterior vertical bands or pillars of the vagina. 13. Clitoris.

ligaments, which are each divided above into three minor folds, diverging from the superior angle of the uterus, and inclosing the *anterior* one, the round ligament of the uterus; the *middle*, the Fallopian tube; and the *posterior*, the ovary.

Dissection.—Remove the peritoneum from the left lateral wall of the pelvis, and the *pelvic fascia* will be found disposed very much as it is in the male. Its vertical layer, however, after covering the superior surface of the elevator muscles of the anus, is reflected upon the exterior of the vagina as well as upon the neck of the bladder. Remove this layer of the fascia, and the *elevator of the anus* will be found to correspond to that in the male in every particular, except that between the neck of the bladder and the rectum, it is inserted into the lateral wall of the vagina. Next, examine the direction and relations of the rectum and bladder, and then the internal organs of generation.

The *rectum* follows the same course as in the male, but its relations are different. Thus, it is here separated from the posterior surface of the uterus and upper third of the vagina, by the posterior *cul-de-sac* of the peritoneum, which often contains a coil or

two of intestine; in the lower part of its extent it is separated from the vagina by the perineum, which, as already described, is a pyramidal or wedge-shaped space, its base presenting below, and occupied by adipose and areolar tissues, and numerous veins.

The *bladder* in the female is situated between the uterus and vagina behind, and the pubis in front, and, on account of the comparative narrowness of the internal between these parts, is flattened antero-posteriorly, so that its transverse diameter is the greatest; but if dissected from its attachments and inflated, it becomes ovoidal, with its axis directed downward and backward. Its anterior and lateral surfaces and summit correspond to the same parts as in the male, but its *posterior surface*, covered throughout with peritoneum, is in relation with the anterior surface of the uterus; its *base* is connected by areolar tissue to the upper part of the anterior wall of the vagina. Its structure is the same as in the male.

The *urethra* in the female is simply a continuation of the neck of the bladder. It is about an inch and a half long, commences in front of the base of the bladder, passes downward and forward beneath the pubic symphysis, and is imbedded in the anterior wall of the vagina. It perforates the perineal fascia or triangular ligament, and opens within the vulva just in front of the projecting edge of the commencement of the vagina, and about half an inch below and beneath the clitoris. It is somewhat curved in its course, the concavity presenting upward and forward; it is held in its position by the reflection of the pelvic fascia forming the anterior ligaments of the bladder, by the deep perineal fascia, and by its connection with the vagina. It consists *externally* of condensed areolar tissue and plexiform veins, surrounded by muscular fibres similar to the compressor muscle of the membranous portion of the male urethra; and, *internally*, of a mucous membrane continuous with that of the bladder. In its ordinary state, it readily admits an instrument two or three lines in diameter, and is remarkable for its great dilatability.

THE VAGINA.

The vagina (Fig. 172) is the membranous canal extending from the vulva to the uterus, and serves for the passage of the menstrual fluid and fœtus. It is situated mostly within the cavity of the pelvis, the axis of the lower part of which it accurately follows, and is, therefore, directed from the uterus downward and forward, describ-

ing a curve with the concavity presenting upward and forward. In consequence of its curved form, its length is greater along its posterior than its anterior wall, the former measuring five or six inches, and the latter only about four. It is cylindrical when distended, but in its ordinary empty condition its anterior and posterior walls are in contact. Owing to this fact, and its great dilatability, it cannot be said to have any fixed diameter; but its entrance or commencement is the narrowest part.

RELATIONS.—The vagina is in relation, *in front*, with the base of the bladder and urethra, to both of which it is closely attached, the latter being imbedded in its structure. Behind, it is separated from the rectum above by the posterior *cul-de-sac* of the peritoneum, and in its lower two-thirds by the perineum, which increases in thickness from above downward. *Laterally*, it is connected for a little way to the lower part of the broad ligaments of the uterus, below which it gives insertion to a part of the elevator muscle of the anus, and still lower down, it is surrounded by cellulo-adipose tissue and a large plexus of veins. Its *superior extremity* embraces the lower part of the neck of the uterus, reaching a little higher behind than in front, so that the circular trench, formed between the two, is somewhat deeper in the latter situation than in front. The *inferior extremity* or mouth of the vagina has been already observed to be an oval opening situated behind the vulva; its circumference is marked by the myrtiform caruncles, and partially closed, in the virgin, by the hymen.

STRUCTURE.—The interior of the vagina is lined by a mucous membrane, the free surface of which presents, in the median line, two longitudinal folds or bands, one upon the anterior, and the other upon the posterior wall, called the *columns of the vagina.* Between these columns the membrane is thrown into numerous transverse folds, technically called the *rugæ*, which are most abundant near the lower extremity, and gradually disappear in the direction of the uterus; they are very prominent in young virgins, but are partially effaced in women who have borne children. The surface of the membrane is soft, and kept constantly moist by the secretions of the mucous glands imbedded in its structure, which are particularly numerous near the neck of the uterus. It is covered by a squamous or tesselate epithelium.

Exterior to the mucous lining is a layer of spongy-looking fibro-areolar tissue, abounding in fibres like those of the dartos layer of the scrotum; it is thickest in the neighborhood of the urethra, and

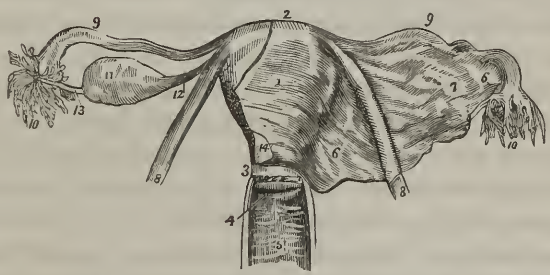
thinnest along the posterior wall. External to this layer the veins form an intricate network, called the *vaginal plexus.*

The *arteries* of the vagina are small but numerous; they are branches of the internal iliac, vesical, internal pudic, and uterine. The *veins* and *lymphatics* correspond, the former forming the plexus above mentioned. The *nerves* are principally derived from the hypogastric plexus of the sympathetic system, but also from the fourth sacral and the pudic nerves, belonging to the cerebro-spinal system.

THE UTERUS.

The uterus or womb is a flattened pear-shaped organ, with its large extremity presenting upward, situated in the cavity of the pelvis, between the bladder and rectum. The direction of its long axis is downward and backward, corresponding to the axis of the superior strait of the pelvis; it forms, with the axis of the body above, an angle of about forty-five degrees. In adult virgins, it measures from 2½ to 3 inches in length, 1½ to 2 inches in breadth at its broadest part, and nearly one inch in thickness; it weighs from

Fig. 173.



Anterior view of the uterus and its appendages. 1. Body of the uterus. 2. Its superior border or fundus. 3. Its neck (cervix). 4. Its mouth (os uteri). 5. The vagina. 6, 6. Broad ligament formed by the peritoneum, which has been removed from the opposite side. 7. Prominence formed by the subjacent ovary. 8, 8. The round ligaments, cut where they enter the internal inguinal ring. 9, 9. Fallopian tubes. 10, 10. Their fimbriated extremities—on the left side, the extremity of the tube is turned forward, to show its mouth or abdominal orifice. 11. The ovary. 12. The utero-ovarian ligament. 13. One of the processes of the fimbriated extremity of the tube connected to the ovary. 14. Cut edge of the peritoneum on the anterior surface of the uterus—this membrane is represented here as descending rather lower upon the organ than is really the case.

one to 1½ oz. In young children it is very small, but is rapidly developed about the age of puberty, and becomes enormously enlarged during gestation. After parturition it rapidly diminishes, but never regains entirely its virgin smallness, or exact shape; so that, by a

little experience, it can be readily ascertained in a *post-mortem* examination from this circumstance, independent of any other, whether the organ has ever been impregnated.

An examination of the exterior of the uterus will discover a little below its middle a slight constriction, which corresponds to a narrowing of its internal cavity, and divides the organ into a body and neck.

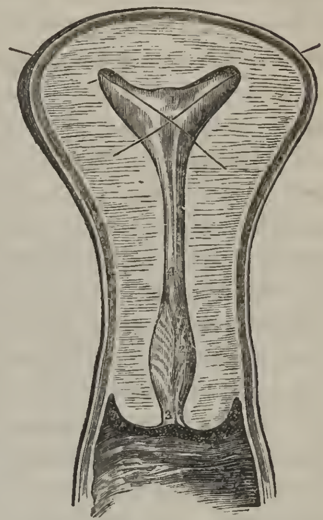
The *body*, looked at either from before or behind, presents a triangular outline; it therefore has three borders, three angles, and two surfaces. The *superior border* or *fundus* rests upon a level with the superior strait of the pelvis; it is convex both antero-posteriorly and transversely, smooth, covered by peritoneum, and in contact with the small intestines. The *lateral borders* or *sides*, which are nearly straight or slightly concave, incline toward each other from above, and give attachment to the broad ligaments. The *superior angles*, formed by the union of the superior and lateral borders, are rounded, and give attachment on each side to the round ligament, Fallopian tube, and ligament of the ovary, in the order, from before backward, in which they are here mentioned. The *inferior angle* is continuous with the neck. The anterior surface is slightly convex, covered by peritoneum, and in relation with the bladder. The *posterior surface* is more convex than the anterior, also covered by peritoneum, and in relation with the rectum, one or more coils of intestine often intervening.

The *neck* (*cervix uteri*), is from four to six lines long, and nearly cylindrical, but flattened slightly before and behind, and expanded a little above, where it is continuous with the body of the organ. Its anterior surface is not invested by peritoneum, but is in immediate contact with the base of the bladder, a layer of loose areolar tissue intervening. The posterior surface is entirely covered by peritoneum, and in relation with the rectum. The two lateral surfaces or borders, give attachment to a part of the broad ligaments of the uterus. The inferior extremity is rounded, projects into the vagina, is covered by mucous membrane, and presents a small transverse slit-like orifice, inclined to be circular in the virgin. It leads to the cavity of the uterus, and hence is called the *mouth of the uterus* (*os uteri*), *vaginal orifice*, or, from its resemblance to the mouth of a tench, *os tincæ*. The two thick borders of this orifice are called the anterior and posterior lips, of which the latter is a little the longer and thinner.

The *interior* of the uterus presents a small cavity, which, in the

body of the organ, is flattened from before backward, so that its anterior and posterior walls are nearly in contact; it is triangular, and its three borders are slightly convex. Its two superior angles are each perforated by an exceedingly minute orifice leading to the Fallopian tube, and its inferior is continuous with the cavity of the neck, by a constricted circular opening called the cervico-uterine orifice. The *cavity of the neck* is also flattened from before backward, and wider at its middle than at either extremity. Upon its anterior and its posterior surface it is marked by a slight median ridge, from which numerous delicate wrinkles or rugæ proceed upward and outward, producing a resemblance to a fern leaf, and called sometimes the *arbor vitæ* (Fig. 174). The uterus is held in its place by the reflections of its peritoneal coat, by the round ligaments, and by the vagina. The reflections of the peritoneum form the two lateral or broad ligaments already mentioned, two folds behind called the *recto-uterine* ligaments, and two in front, called the *vesico-uterine*. The *round ligaments* are two rounded fibrous cords, which originate one on each side, from the superior angle of the uterus, pass outward and forward between the two layers of the lateral ligament, enter the internal inguinal ring, descend along the inguinal canal, and become blended with the cellulo-adipose tissue of the mons Veneris.

Fig. 174.



Transverse section of the uterus, and part of the vagina. 1. Cavity of the body. 2. Cavity of the neck, its walls marked by fine oblique ridges. 3. Cervico-vaginal orifice (os uteri). 4. Cervico-uterine orifice. The two bristles are introduced through the orifices of the Fallopian tubes.

Structure.—The uterus is lined internally by a mucous membrane, which in the body of the organ is of a light color, smooth, very thin, and closely attached to the subjacent tissue. Examined with a microscope, it is found to be covered with a ciliated columnar epithelium, as far as the middle of the neck, where it becomes squamous like that of the vagina, with which it is continuous. Upon its surface are also observed numerous minute orifices leading to little tubular glands, something like those found in the intestine ; they are especially well seen in the impregnated organ. In the cavity of the neck, between the little ridges, are numerous mucous follicles, which

secrete the tenacious mucous plug that closes this outlet during pregnancy. Sometimes one or more of these follicles present the appearance of little, transparent, vesicular bodies, called in the books the *ovula of Naboth*, which is produced by an obstruction in their ducts, and consequent accumulation of their secretion.

External to the mucous lining, and beneath the partial coat formed by the peritoneum, is the proper uterine tissue upon which the size and thickness of the organ depend. It is very dense and firm, cuts very much like cartilage, and consists of bundles of plain muscular fibres closely interwoven and held together by an abundance of strong fibro-areolar tissue. In the virgin organ, no particular arrangement of these fibres can be made out, but when enlarged by pregnancy, the following disposition is found to occur: 1. Several superimposed circular laminæ surrounding the neck like a sphincter; 2, a superficial layer, originating upon each side of the body as far as the median line, the fibres converging to be inserted into the round ligaments; 3, a deep layer, situated just beneath the mucous membrane, consisting of concentric bundles of fibres surrounding the orifice of each Fallopian tube, the outermost circles of fibres touching each other in the median line. Between these last two layers the muscular bundles have no regular arrangement, but cross each other in every direction.

Vessels and Nerves.—The *arteries* of the uterus are very small in the quiescent state of the organ, but become much enlarged during pregnancy, and ramify in a very tortuous manner. They are derived from two sources; the principal are the two *uterine*, which arise, one on each side, from the internal iliacs, and reach the organ between the layers of the lateral ligaments. It receives branches also from the *spermatic* or *ovarian*, which arise from the aorta, as in the male, and are distributed principally to the ovaries. The *veins* correspond to the arteries, but present a much more remarkable enlargement during pregnancy; they are very tortuous, destitute of valves, and composed of only a continuation of the internal venous coat, and hence they are sometimes called uterine sinuses. The *lymphatics* are very numerous, and terminate in the glands situated along the internal iliac vessels and the lumbar vertebræ. The *nerves* can, with the greatest difficulty, be followed into the substance of the virgin uterus, but in the gravid organ they may be readily traced throughout every part of the muscular tissue in which they form numerous large plexuses. They are derived from the renal and hypogastric plexuses, and accompany the spermatic and uterine arteries. Those from the

hypogastric plexus contain a few white fibres from the cerebro-spinal system, which are distributed principally to the neck of the organ.

THE FALLOPIAN TUBES.

The Fallopian tubes or oviducts (Fig. 173) are two membranous canals from three to four inches in length, continuous with the superior angles of the uterus, and inclosed, one on each side, by the middle fold of the lateral ligament. Traced from their connection with the uterus, they are at first small, cylindrical, and cord-like, but they gradually increase to the size of a large goose-quill at their outer extremities, which are free or floating between the abdominal and pelvic cavities, and present numerous fringe-like processes technically called *fimbriæ.* The direction of each tube is at first transverse, but having come within a short distance of the outer border of the superior strait of the pelvis, they make a curve with the concavity presenting backward and downward. The outer or fimbriated extremity looks, therefore, toward the corresponding ovary, to the outer extremity of which it is attached by one of the fringe-like slips or fimbriæ. The canal of the tube corresponds somewhat in shape to that of its exterior; it is exceedingly small where it communicates with the uterus, barely admitting a fine bristle, but gradually expands towards its outer extremity, whose patulous orifice communicates ordinarily with the sac of the peritoneum, but, during the monthly excitement, is applied to the surface of the ovary.

Structure.—Its walls are thick and firm near the uterus, but become thinner toward the fimbriated extremity, and consist, like the uterus, of three structures, namely, a serous, a muscular, and a mucous tunic. The *serous coat* is derived from the peritoneum, and invests the whole of the exterior of the tube, except a narrow space along its lower border. The *muscular coat* consists of plain fibres closely interwoven with an abundance of fibro-areolar tissue, and is in all respects similar to the proper tissue of the uterus. The mucous lining is a prolongation of that of the uterus, and is continuous at the fimbriated extremity of the tube with the serous lining of the abdomen, this being the only instance of the kind in the body. The epithelium covering the mucous membrane is ciliated and columnar, and continuous with the squamous layer upon the inner surface of the peritoneum.

THE OVARIES.

The ovaries (Fig. 173), the homologues of the testicles in the male, are two oval-shaped bodies about as large as an almond, of a whitish or pale pink color, and a somewhat uneven surface. They are situated, one upon each side, in the posterior fold of the lateral ligament of the uterus, and connected to the corresponding superior angle of this organ, by a small fibrous band called the *ligament of the ovary*, and by its opposite extremity to one of the fimbriæ of the Fallopian tube. In the fœtus, they are placed in the cavity of the abdomen just below the kidneys. They afterwards descend to the superior back part of the pelvic cavity, and are again carried upward during pregnancy, by the enlargement of the uterus into the cavity of the abdomen, where they occasionally become confined by adhesion. After parturition, however, they are generally found in the iliac fossæ. They vary considerably in size in different individuals, but are generally larger in adult virgins than in matrons, and measure about one and a half inches in length, and three-fourths or one inch in thickness. Like the testicles, they are small in early life and undergo rapid development at the age of puberty.

STRUCTURE.—The ovary has a partial investment of serous membrane derived from the peritoneum, beneath which is a complete envelop of strong fibrous membrane closely connected to the inclosed tissue. The latter, the *proper tissue* of the organ, is a firm, dense, pinkish-white, granular structure, called the *stroma*, in which are found from twelve to twenty or more vesicular bodies or cysts varying in size from a pin's head to a small pea, and containing a clear albuminous fluid. These cysts, called the *Graafian vesicles*, ovi-capsules, or ovi-sacs, are composed of two thin coats, an external vascular, and an internal serous-looking, called ovi-capsule, which has an internal granular surface in contact with the inclosed fluid. Floating in this fluid is the true *ovum*, a small spherical body about $\frac{1}{120}$ of an inch in diameter, composed of a transparent envelop and an inclosed granular fluid called the *yolk*. In the yolk is a still smaller *germinal vesicle*, measuring about $\frac{1}{720}$ of an inch in diameter, in which is an opaque spot $\frac{1}{3000}$ of an inch in diameter, named the germinal spot. The ovum, at first loose and floating in the albuminous fluid of the ovi-capsule, increases in size and becomes adherent to the internal or granular surface of the latter. While this is going on, the vesicle approaches the surface of the ovary and forms a pro-

minence beneath its serous and fibrous envelops. Finally, the ovum bursts through the superjacent structures and is received into the Fallopian tube, whose fimbriated extremity, at the time, grasps the organ in such a manner, that its open mouth is applied over the point upon the ovary at which the rupture takes place. After the escape of the ovum, the little lacerated spot cicatrizes, and the Graafian vesicle becomes contracted and yellow, forming what is technically called a *corpus luteum*. In the course of time this corpus luteum becomes absorbed, and not the least vestige of it can be discovered, but the little cicatrice on the surface of the ovary may be detected for a long time afterward.

The time required for the complete maturation of the ovum is not positively ascertained, but it is now generally believed that one escapes at each monthly period from one or the other ovary, or from both.

VESSELS AND NERVES OF THE PELVIC CAVITY.

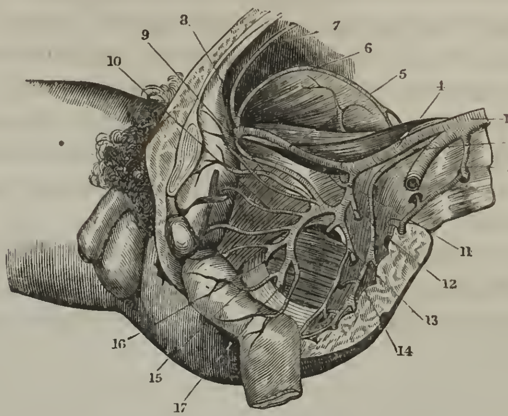
DISSECTION.—The arteries and veins of the cavity of the pelvis are branches of the internal iliac, and may be easily dissected by commencing at the trunks of these vessels and following out their subdivisions. The nerves belong to the cerebro-spinal and sympathetic systems, and require much more care in their exposure; those from the spinal cord emerge at the anterior sacral foramina and form a large plexus (sacral plexus) on each side in the lower back part of the pelvis, and can be readily brought into view by turning the rectum to the opposite side; the sympathetic lie alongside of the sacral foramina, and may be distinguished by their pearly white color and the enlargements or ganglia that occur at different points. Branches from the abdominal ganglia, sacral plexus, and particularly from the sacral ganglia of the sympathetics, unite to form a large plexus (hypogastric plexus) in front of the promontory of the sacrum, and will demand for complete exposure (which the beginner is not advised to attempt), a careful removal of the rectum and the surrounding cellular and adipose tissue.

The INTERNAL ILIAC ARTERY commences at the bifurcation of the common iliac, upon the brim of the pelvis in front of the sacro-iliac symphysis, descends almost vertically to the superior margin of the sacro-ischiatic foramen, a distance of about an inch and a half, and divides into an anterior and a posterior branch. In its course it crosses the inner border of the psoas muscle, rests upon the internal iliac vein, lumbo-sacral nerve, and upper part of the pyriform muscle, is covered in front by the peritoneum, and crossed by the corresponding ureter.

The *anterior* division gives off the superior and inferior vesical,

middle hemorrhoidal, obturator, internal pudic, and ischiatic or sciatic arteries; the *posterior*, the ilio-lumbar, lateral sacral, and gluteal

Fig. 175.



Arteries of the pelvis. 1. Termination of the aorta. 2. Middle sacral artery. 3. A lumbar artery. 4. Primitive iliac. 5. External iliac. 6. Circumflex iliac. 7. Epigastric. 8. Remains of the umbilical artery of the fœtus converted into a ligament. 9. Obturator. 10. Vesical. 11. Ilio-lumbar. 12 and 13. Lateral sacral arteries. 14. Gluteal artery. 15. Middle hemorrhoidal. 16. Internal pudic. 17. Sciatic.

arteries. The origin of these vessels, however, is subject to great variation.

1. *Anterior Division.*—The *superior vesical artery* is the first portion of the umbilical of the fœtus, which remains pervious as far as its branches to the bladder, but beyond this point is converted into a fibro-areolar cord contained in a fold of the peritoneum. It is small, ascends forward from its origin, and gives branches to the side of the bladder.

The *inferior vesical artery* not unfrequently originates from one of the other branches of the internal iliac, but generally from the anterior division immediately below the preceding. It is very small and short, passes inward, and is distributed to the base of the bladder and prostate gland.

The *middle hemorrhoidal artery* frequently comes off by a common trunk with the preceding, and in other cases some distance below; it passes horizontally inward, and is distributed upon the lower part of the rectum.

The *obturator artery*, although generally a branch of the anterior division of the internal iliac, sometimes comes from the posterior, and sometimes from the external iliac, beneath the crural arch. From its usual point of origin it is directed forward along the lateral wall

of the pelvis, passes through the opening in the obturator membrane in company with the obturator nerve, and is distributed to the muscles upon the inner side of the thigh. When it is a branch of the external iliac or femoral (which, according to my observation, takes place about once in every three subjects), it usually arises by a common trunk with the epigastric, passes inward along the posterior border of the inner extremity of the crural arch, as far as the spine of the pubis, thus almost encircling the internal femoral ring, and then descends vertically behind the body of the pubis to reach the opening in the obturator membrane. In other cases it comes off singly, and descends immediately along the outer border of the femoral ring to the above-mentioned opening. It is distributed to the muscles upon the inner side of the thigh.

The *internal pudic artery*, larger than the preceding, descends immediately from its origin, across the front of the pyriform muscle and sacral nerves, to reach the great sacro-ischiatic foramen, through the lower part of which it leaves the cavity of the pelvis in company with the sciatic artery; it immediately re-enters, however, through the small sacro-ischiatic foramen, and having crossed the posterior surface of the spine of the ischium, it gains the inner surface of the tuberosity of the ischium, ascends forward and toward its fellow of the opposite side along the inner surface of the ramus of the ischium and pubis, perforates the deep perineal fascia beneath the arch of the pubis, and divides into its two ultimate branches, the dorsal artery of the penis, and the artery of the cavernous body. While situated upon the inner surface of the tuberosity of the ischium, it is at least an inch from the lower border of this bone, but as it ascends the ramus, it gradually approaches its anterior border and crosses it beneath the pubic arch. It is accompanied by a corresponding vein and nerve, and gives off in its course the following principal branches: 1. The *inferior* or *external hemorrhoidal* to the lower part of the rectum; 2. The *superficial perineal* to the superficial parts of the perineum and back of the scrotum; 3. The *artery of the bulb*, given off from the main trunk while lying between the middle and deep layers of the perineal fascia, and distributed to the bulb of the penis as before seen. 4. The *artery of the cavernous body* of the penis, which enters the root of this organ and ramifies throughout its cells; 5. The *dorsal artery of the penis*, which runs along the corresponding side of the groove between the two cavernous bodies upon the upper surface of the penis, and is distributed principally to the head of this organ.

Sometimes the internal pudic is very small, and terminates in the artery of the bulb or in the superficial perineal. In this case, the deficiency is made up by the existence of an anomalous vessel, called the *accessory pudic.* This accessory vessel, when present, generally originates by a common trunk with the internal pudic, descends alongside of the base of the bladder, passes over the superior surface of the prostate, then along by the membranous portion of the urethra, and, perforating the deep and middle layers of the perineal fascia, terminates in the dorsal artery of the penis and cavernous artery. Its relations to the prostate gland and membranous portion of the urethra are of the utmost importance in a surgical point of view; but, happily for the lithotomist, its existence is by no means common.

The internal pudic in the female is much smaller than in the male, but follows the same course and gives off: 1, a *superficial perineal branch* to the labia; 2, a *bulbous branch* to the erectile tissue behind the labia; and two small branches to the clitoris, one of them corresponding to the dorsal artery of the penis in the male.

The *ischiatic* or *sciatic artery*, a little larger than the pudic, descends in front of the pyriform muscle, leaves the cavity of the pelvis at the lower part of the great sacro-ischiatic foramen in company with the sciatic nerve, continues its descent midway between the tuberosity of the ischium and great trochanter, and is distributed to the muscles on the upper back part of the thigh, sending also a twig to the sciatic nerve and one or two to the hip-joint.

The *uterine artery*, also a branch of the anterior division of the internal iliac, in the female, passes downward between the layers of the lateral ligament, then ascends in a tortuous manner along the border of the uterus, and gives off numerous branches which enter the substance of the organ. This vessel becomes very much enlarged during pregnancy.

The *vaginal artery* corresponds to the inferior vesical in the male, ascends in the lateral wall of the vagina, and sends branches also to the base of the bladder.

2. Posterior Division of the Internal Iliac.—The *gluteal artery* is the largest of the branches of the internal iliac, but its course within the cavity of the pelvis is very short, for it almost immediately turns around the upper margin of the great sacro-ischiatic foramen, to be distributed to the muscles upon the outer surface of the ilium. Having left the pelvic cavity, it immediately divides into two branches—a *superficial*, which ramifies between the large and middle gluteal muscles, perforates the former, and anastomoses on the back of the sacrum with the sacral arteries, and a *deep* branch, which follows the middle curved line on the dorsal

surface of the ilium, between the middle and small gluteal muscles, and is distributed to all the adjacent parts as far as the anterior border of the bone.

The *ilio-lumbar artery*, much smaller than the gluteal, ascends beneath the psoas muscle and external iliac artery and vein, to the margin of the iliac fossa, where it divides into a *lumbar* and an *iliac* branch. The former is distributed to the psoas and square muscles, and sends branches through the intervertebral foramina to the parts within the spinal canal; the latter enters the substance of the iliac muscle, and anastomoses with the circumflex artery of the ilium (a branch of the external iliac beneath the crural arch) near the superior anterior spinous process of this bone.

The *lateral sacral arteries*, usually two in number, descend a little inward in front of the pyriform muscle, and divide into several branches, which enter the anterior sacral foramina to be distributed to the back of the nerves situated in the sacral portion of the spinal canal. Some of the branches continue on through the posterior sacral foramina, and are spent upon the cutaneous and muscular tissues in this situation.

The INTERNAL ILIAC VEIN is formed by the union of veins that accompany the several branches of the internal iliac artery. It ascends in front of the corresponding sacro-iliac symphysis, behind the internal iliac artery, and unites with the external iliac vein to form the common iliac. It returns the blood from the pelvic organs, the external organs of generation in the female, the penis in the male, and the muscles on the back of the ilium.

The ANTERIOR SACRAL NERVES are six in number on each side, and very large. The first four emerge at the anterior sacral foramina, are joined by the lumbo-sacral (a branch of the lumbar plexus), and converge toward the great sacro-ischiatic foramen to form the *sacral plexus*. The last two (the fifth and sixth) are very small, descend through the lower extremity of the sacral canal, and are distributed to the coccygeal muscle and neighboring integument.

The *sacral plexus*, formed, as above mentioned, by the interlacement of the lumbo-sacral and first four anterior sacral nerves, is flattened from before backward. It is triangular, rests upon the anterior surface of the pyriform muscle, and is covered in front by the pelvic fascia and internal iliac vessels. Its *collateral* branches are: 1, three or four small filaments to the back of the rectum, base

of the bladder, and hypogastric plexus in front of the sacral promontory; 2, a small branch to the elevator of the anus; 3, a filament to the internal obturator muscle; 4, the *internal pudic* nerve which accompanies the artery of the same name; 5, a small branch to the square and twin muscles on the back of the thigh; and, 6, the *small sciatic* nerve, which, as will be hereafter seen, passes through the great sacro-ischiatic foramen to be distributed to the great gluteal muscle, and the integument of the back of the thigh. The *terminal* branch is the *great sciatic* nerve, the largest nerve in the body, which arises from the inferior extremity of the plexus, and descends through the great sacro-ischiatic foramen, below or in front of the pyriform muscle, in company with the sciatic artery. Its course along the back of the thigh will be hereafter seen.

The SYMPATHETIC NERVE in the pelvis is a continuation of the two lumbar nerves, but is very small. It lies upon the anterior surface of the sacrum along the inner side of the sacral foramina, opposite each of which it presents a small oval enlargement or ganglion. From these ganglia branches are given to the hypogastric and sacral plexuses, and from the last of the series a filament crosses to its fellow of the opposite side, and presents, at its middle, a small enlargement called the *azygos ganglion* (*ganglion impar*).

The *hypogastric plexus* is situated in the areolar tissue behind the rectum, and in front of the upper part of the sacrum. It is made up of numerous small filaments from both the sympathetic and cerebro-spinal systems. The branches from the sympathetic system are derived principally from the aortic plexus situated upon the front of the aorta, between the superior and inferior mesenteric arteries. They vary in number from ten to fifteen on each side, are very small, and descend alongside of the aorta and over the common iliac arteries. The white or cerebro-spinal filaments are offsets from the sacral plexus. After uniting in a very intricate manner, the fibres of the plexus divide into two sets, which proceed forward by the side of the rectum, forming what are called the inferior hypogastric plexuses. From these lateral prolongations, filaments are distributed to all of the contained viscera, the white or cerebro-spinal fibres being distributed for the most part to the neck of the bladder, vagina, neck of the uterus, and lower extremity of the rectum.

The *coccygeal muscle*, also seen in this dissection situated in front of the sacro-ischiatic ligaments, is thin, flat, and triangular; it

arises broad from the border of the coccyx and adjacent part of the sacrum, and is inserted by a narrow-pointed extremity into the inner surface of the spine of the ischium. It is in relation, anteriorly and laterally, with the dilated portion of the rectum, posteriorly and inferiorly, with the sacro-ischiatic ligaments and great gluteal muscle.

Use.—To raise the coccyx forward, and thus assist in defecation; the action of only one muscle would draw the coccyx toward the corresponding side.

THE INFERIOR EXTREMITIES.

Having completed the dissection of the interior of the pelvis, the student may proceed to that of the lower limbs, devoting the left one, which (if the preceding directions have been followed) remains attached to the trunk, to the special study of the muscles, and reserving the right, which has been already laid aside, for the dissection of the bloodvessels and nerves.

MUSCLES OF THE INFERIOR EXTREMITY.

Before commencing the dissection of the muscles of the lower extremities, it is well enough to previously consider, in a general way, the movements of which they are capable. Obviously, their most important function is progression. For this, several combined and opposite movements are necessary: thus, in raising the foot from the ground, the thigh is bent forward, the leg backward, the foot upward, and the toes downward; or, in other words, the thigh is *flexed* upon the pelvis, the leg upon the thigh, the foot upon the leg, and the toes upon the foot. But when the foot is pressed upon the ground to carry the body forward, the movements are reversed; the toes are *extended* upon the foot, the foot upon the leg, the leg upon the thigh, and the thigh upon the pelvis. It will be readily understood, then, that the muscles which perform these movements are placed alternately upon the anterior and posterior aspects of the limb, and upon the part or section above the one to be acted upon. Thus, the flexors of the thigh are placed upon the front of the pelvis, the extensors of the leg upon the front of the thigh, the flexors of the foot and extensors of the toes upon the front of the leg and foot, the extensors of the thigh upon the back of the pelvis, the flexors of the leg upon the back of the thigh, and the extensors

of the foot and flexors of the toes upon the back of the leg and bottom of the foot.

But in addition to the straightforward and backward movements, the several large joints of the lower extremities are capable of more or less lateral movement (abduction and adduction) and rotation. These are most extensive at the hip-joint, slight at the ankle, and almost entirely wanting at the knee.

To perform these several movements, each limb is provided with fifty-seven muscles, of which twelve are situated upon the pelvis, anteriorly and posteriorly, thirteen upon the thigh, twelve upon the leg, and twenty upon the foot. The excellent practical arrangement of these muscles taught by Prof. Palmer, of the University of Louisville, is inserted here, although it is not supposed that the student will fully appreciate it, until, by dissection, he has become familiar with the individual muscles themselves.

In the first place, each limb is divided into four *regions*—the pelvic, the femoral (region of the thigh), the crural (region of the leg), and the pedal (region of the foot)—which are subdivided into anterior pelvic, posterior pelvic, anterior femoral, posterior femoral, internal femoral, &c. Secondly, some of these regions contain muscles acting upon different parts, which gives rise to a division into *classes*. For instance, upon the thigh, there are muscles that move the thigh, and others that move the leg; upon the leg, muscles that move the foot, and some that move the toes, &c. Thirdly, these classes comprise muscles whose special function is different, some being flexors, some extensors, &c., which justifies a farther division into *groups*. Lastly, some of the groups consist of one or more *layers*.

With this explanation, the student will understand the following tables.

I. PELVIC REGION—(Anterior and Posterior.)

One Class—(*Movers of the Thigh.*)

Three Groups—(*Flexors, Extensors, and Rotators.*)

1. *Flexors*	1. Small psoas muscle. 2. Large psoas muscle. 3. Iliac muscle.
2. *Extensors*	1. Large gluteal muscle. 2. Middle gluteal muscle. 3. Small gluteal muscle.

3. *Rotators* . . . . .
- 1. Pyriform muscle.
- 2. Internal obturator muscle.
- 3. External obturator muscle.
- 4. Superior twiu muscle.
- 5. Inferior twin muscle.
- 6. Femoral quadrate or square muscle.

II. FEMORAL REGION—(Anterior, Internal, and Posterior.)

First Class—(*Movers of the Thigh.*)

One Group.

Adductors . . . . .
- 1. Pectineal muscle.
- 2. Large adductor muscle.
- 3. Long adductor muscle.
- 4. Short adductor muscle.

Second Class—(*Movers of the Leg.*)

First Group . . . .
- 1. Tensor of the femoral fascia.
- 2. Sartorial muscle.
- 3. Gracilis muscle.

Second Group—*Extensors*
- 1. Straight femoral muscle.
- 2. Triceps muscle.

Third Group—*Flexors* .
- 1. Semi-tendinous muscle.
- 2. Semi-membranous muscle.
- 3. Biceps muscle.
- 4. Popliteal muscle.

III. CRURAL REGION—(Anterior, External, and Posterior.)

First or Anterior Tibial Group.

1. Anterior tibial muscle—a flexor of the foot.
2. Long extensor of the great toe.
3. Common long extensor of the toes.

Second or Peroneal Group.

1. Long peroneal muscle
2. Short peroneal muscle } Extensors of the foot.
3. Third peroneal muscle—a flexor of the foot.

Third or Posterior Tibial Group.

Superficial layer
- 1. Gastrocnemius
- 2. Soleus
- 3. Plantaris

} Extensors of the foot.

Deep layer . .
- 1. Posterior tibial—an extensor of the foot.
- 2. Common long flexor of the toes.
- 3. Flexor of the great toe.

IV. PEDAL REGION—(Dorsal and Plantar.)

First Class—(*Movers of the Toes in General.*)

First Group.

1. Short extensor of the toes.

Second Group.

1. Short flexor of the toes.
2. Accessory flexor of the toes.

Third Group.

1. Four lumbricales.
2. Transverse muscle.
3. Eight interosseous muscles—adductors and abductors of the toes.

Second Class—(*Movers of Individual Toes.*)

First Group.

1. Short flexor of the great toe.
2. Short flexor of the small toe.

Second Group.

1. Abductor of the great toe.
2. Abductor of the small toe.

1. FEMORAL REGION—ANTERIOR.

The muscles of the thigh are invested by the skin, superficial fascia or subcutaneous areolar tissue, and a strong fibrous membrane called the *femoral aponeurosis* or *fascia lata.* In the subcutaneous areolar tissue are a number of veins, branches of the internal or long saphenous vein, which passes from the leg along the inner side of the thigh, toward the groin, resting upon the external surface of the femoral aponeurosis.

Dissection.—The skin and superficial fascia may be removed together, so as to expose the surface of the femoral aponeurosis, and the internal saphenous vein. For this purpose, place a block under the upper back part of the thigh, and make an incision from the middle of the crural arch, passing along the middle of the anterior surface of the thigh over the anterior surface of the patella, to about an inch below the anterior tuberosity of the tibia. Next, intersect the lower extremity of this long incision by a transverse one, extending across the upper part of the leg. Dissect back the skin from the middle line, carrying the outer flap as far around as can be conveniently done, and the internal one as far as the prominent ridge, formed along the inner side of the thigh by the gracilis muscle.

In performing this dissection, a number of lymphatic glands will be noticed in the region of the groin; and here, also, the subcutaneous areolar tissue will be seen to be very abundant, divisible into several layers, and

traversed by numerous small veins and arteries. The deep portion of this areolar tissue is here styled the *cribriform fascia*, and forms one of the coverings of a hernia in this situation. Immediately below this point the superficial fascia is closely adherent to the femoral aponeurosis, a fact whose practical bearing will be pointed out in connection with femoral hernia.

The nervous filaments divided in turning back the skin and fascia, are cutaneous branches of the lumbar and crural nerves.

The FEMORAL APONEUROSIS (*fascia lata*) is a fibrous membrane, which forms a common envelop or sheath for the muscles of the thigh, for the purpose of binding them firmly in their places during their contractions. It is exceedingly dense and strong along the outer aspect of the limb, and beneath the crural arch and anterior spines of the ilium; but weak, thin, and blended with the superficial fascia, along the inner surface of the thigh, and upon the nates. It is attached *above* to the sacrum, coccyx, crest of the ilium, anterior margins of the large and middle gluteal muscles, crural arch, body and spine of the pubis, and ramus and tuberosity of the ischium; *externally*, to the whole length of the rough line (*linea aspera*) of the femur, forming in this situation a strong septum, between the muscles upon the outer, and those upon the back part of the thigh; *internally*, it is also prolonged down to the same rough line of the femur, forming a thinner septum between the extensor and adductor muscles; *below*, it is connected to the condyles of the femur, tuberosities of the tibia, and head of the fibula, covers the patella, a bursa intervening, and is continuous with the tendons of several of the muscles that surround the knee. It moreover sends numerous thin processes or layers from its deep surface, to form separate sheaths for the individual muscles underneath.

The femoral aponeurosis is perforated at different points for the passage of vessels and nerves, but the openings are generally small and unimportant, except the one occupied by the internal saphenous vein. This is situated in the bottom of a considerable depression found just beneath the inner extremity of the crural arch; it is vertically oval in form, and bounded externally and above by a prominent crescentic border, continuous with the internal extremity of the crural arch. (For an account of this opening, and its relations to femoral hernia, see a future page.)

The femoral aponeurosis is composed of bundles of closely interwoven white fibres, which for the most part run horizontally around the limb. At its thickest part the longitudinal fibres are equally numerous, and at one point form a thickened band one or two inches broad, which originates from the anterior superior spinous process

of the ilium, and the adjacent part of the crest, extends almost vertically downward, and is inserted into the outer side of the head of the tibia. Just beneath the superior spine of the ilium, the aponeurosis is separable into two layers, which inclose the tensor muscle.

Dissection.—*To expose the anterior muscles of the thigh*, the femoral aponeurosis may be divided by a vertical incision, extending from the pubes to the inner aspect of the knee, and turned outward, cutting it from its several attachments above and below, and dividing the intermuscular septa that come from its under surface. It may be then entirely detached by dividing the septum that dips down to the rough line of the femur, to separate the muscles upon the outer from those upon the posterior aspect of the limb. This having been done, the muscular sheaths may be dissected out as occasion requires, preserving the main vessels and nerves. To expose the tensor muscle of the fascia, the outer layer of this structure must be divided in a longitudinal direction, for the distance of a few inches below the superior anterior spinous process of the ilium, and turned aside.

The tensor muscle of the femoral fascia (*tensor vaginæ femoris*) (Fig. 176, 1), short, flat, and quadrilateral, is situated between the two layers of the femoral aponeurosis, in the upper outer part of the thigh. It originates tendinous from the outer surface of the superior anterior spine of the ilium, between the middle gluteal and sartorial muscles, passes downward and a little backward to the distance of three or four inches, and is inserted into the thick band-like portion of the femoral aponeurosis.

Use.—To make the aponeurosis tense, and rotate the thigh slightly inward. The latter action is effected by means of the thick band-like portion of the aponeurosis, which is inserted into the outer condyle of the femur, and corresponding tuberosity of the tibia.

Relations.—Inclosed by the two layers of the femoral aponeurosis, it is at first placed between the middle gluteal and sartorial muscles, and in its course lies nearly parallel with and upon the anterior margin of the former, diverging from the latter to form an angular interval, in which a part of the rectus muscle may be seen.

The sartorial muscle, the longest in the body, is narrow, flattened, and somewhat larger a little below its middle than at either extremity. It arises, by short tendinous fibres, from the superior anterior iliac spine, and upper half of the subjacent notch, descends inward, crossing the superior and middle thirds of the thigh obliquely, to reach the back part of the internal condyle of the femur, where, becoming tendinous, it continues on in a vertical direction, and having passed the knee-joint, turns forward, and spreads out to be inserted into the crest of the tibia just below the tubercle.

Use.—To flex the leg upon the thigh, turning it at the same time inward, across the opposite, and when this is accomplished, to flex and adduct the thigh upon the pelvis; if the leg is fixed as in standing, it may flex the trunk upon the thighs, and rotate it in an opposite direction.

Fig. 176.

Muscles of the anterior femoral region. 1. Tensor of the femoral aponeurosis. 2. Pectineus. 3. Rectus or straight femoral. 4. External head (vastus externus) of the triceps extensor. 5. Internal head (vastus internus) of the same. 6. Sartorius. 7. Long adductor.

Relations.—The sartorial belongs to the superficial group, and is covered, therefore, by only the femoral aponeurosis and skin. It crosses in its course the femoral portion of the internal iliac and psoas, the triceps, internal head of the biceps, long adductor, gracilis, and great adductor muscles, and at its insertion, lies in front of the tendons of the semitendinous and gracilis muscles, a bursa intervening. Its most important relation, however, is with the femoral vessels; thus, in the superior third of the thigh, it forms, with the crural arch and long adductor muscle, a triangular space, through the middle of which the femoral artery takes a nearly vertical course, accompanied by the femoral vein and crural nerves; in the middle third, the muscle lies obliquely across the vessels, which may be, therefore, found along its superior or inferior borders; in the lower third, the artery is situated upon the back of the limb, and has no immediate relation with the muscle.

The gracilis muscle, long and slender, flattened laterally, and gradually tapering from above downward, forms the inner border of the anterior region of the thigh. It arises, by a short but broad tendon, from the anterior surface of the internal extremity of the pubic bone, close to the lower part of the symphysis, and from the descending ramus of the same, descends almost vertically to the back part of the internal condyle of the femur, where it ends in a

rounded tendon, which turns around the knee to be inserted into the crest or spine of the tibia, behind the attachment of the sartorial.

Use.—To flex the leg, turning it at the same time inward; and secondarily, to adduct the thigh. Acting from the leg as a fixed point, it assists in flexing the trunk upon the thighs.

Relations.—The gracilis belongs to the superficial femoral group, and is covered, therefore, by only the femoral aponeurosis and skin. Its internal or deep surface is in contact, in the upper part of the thigh, with the adductor group of muscles, and below, with the knee-joint and internal lateral ligament of the same, a bursa, common to the semitendinous, intervening. At its insertion, it is covered by the expanded tendon of the sartorial, with which, and that of the semitendinous, it is connected by an aponeurotic expansion.

Dissection.—Detach the tensor of the femoral fascia from its connections, and turn the sartorial inward, and the crural extensor group, consisting of the rectus and triceps, already in a great measure exposed, will be brought fully into view.

The rectus or straight muscle is one of the large muscles of the thigh, and extends in the middle line of the limb in front, from the pelvis to the upper part of the leg. It is somewhat fusiform in shape, being larger at the middle than at either extremity, flattened from before backward, and bipenniform, its fibres running obliquely toward a central aponeurotic septum. It arises by two short, rounded tendons, one from the inferior anterior iliac spine, and the other from the internal border of the acetabulum and capsular ligament, descends almost vertically, inclining a little inward, and is inserted by a broad flattened tendon into the upper border of the patella, in common with the triceps, and through the ligament of the patella into the lower part of the tuberosity of the tibia.

Use.—To extend the leg, and, secondarily, to assist in flexing the thigh, or, if the leg is the fixed point, to assist in flexing the trunk upon the lower extremities.

Relations.—The superior extremity of the muscle is crossed obliquely from above, downward and inward, by the sartorial, overlapped internally by the outer border of the iliac muscle, and externally, by the tensor of the femoral fascia and middle and small gluteal muscles; it rests, above, upon the capsular ligament of the hip-joint, and below this point, rests upon the middle portion of the triceps; it is covered throughout the lower three-fourths of its extent by only the femoral aponeurosis and skin.

Dissection.—Divide the rectus within three or four inches of its origin, and turn it downward.

The triceps extensor muscle of the leg is the largest muscle in the femoral region, and consists, as its name indicates, of three heads or divisions, of which the external is commonly called the *vastus externus*, the internal, the *vastus internus*, and the middle, the *crureus*. The *external* head (*vastus externus*) (4), the largest of the three, arises tendinous from the root of the great trochanter, from the external edge of the rough line (*linea aspera*) of the femur, and from the bifurcation of this line, which leads to the external condyle, and fleshy from that process of the femoral aponeurosis that separates it from the muscles upon the posterior aspect of the thigh, and from the surface of the bone upon which it lies. "Its external surface is tendinous above, and fleshy below; its internal is fleshy above, and tendinous below." Its fibres pass downward and inward, with different degrees of obliquity, the most inferior being nearly horizontal; they become partly blended with those of the middle and internal head, and partly with the tendon of the rectus, and are *inserted* into the outer half of the upper border of the patella. This head may be separated from the middle or crureus almost to the patella, and is covered throughout by the femoral aponeurosis, but overlapped above by the great gluteal muscle, and crossed by the tensor of the fascia. The *internal* head (*vastus internus*) (5), occupies the inner aspect of the thigh. It is broad below, and pointed above. It arises tendinous from the inter-trochanteric line, and from the whole length of the inner edge of the rough line (*linea aspera*), and fleshy from the surface of the bone upon which it lies, and the aponeurotic prolongation of the femoral fascia that separates it from the adductor muscles; its fibres descend obliquely forward, and are inserted into the tendon of the rectus, the side of the patella, and, by an aponeurotic expansion covering the inner side of the knee-joint, into the head of the tibia. It is covered above by the sartorial, and throughout the remainder of its extent by the femoral aponeurosis.

The *middle* head (*crureus*) is situated between the internal and external, and so intimately blended with the former, that the two cannot be separated. It arises from the anterior surface of the femur between the inter-trochanteric line above, to within three or four inches of the knee, passes downward and a little forward, and is inserted tendinous into the upper border of the patella, behind the insertion of the rectus. It lies beneath the rectus, and is separated

from the bone below by a very large bursa, which generally communicates with the knee-joint; or, more properly, the synovial membrane of the knee-joint is generally prolonged upward beneath the muscle upon the anterior surface of the bone, to the distance of two or three inches, or sometimes even to a greater extent.

ACTION.—The true insertion of the triceps being the base of the tubercle or anterior tuberosity of the tibia, through the ligament of the patella common also to the rectus, its special action is extension of the leg. It is probably the most powerful muscle in the body, and its sudden contraction has been known to fracture the patella, and tear away the tuberosity of the tibia, to which it is attached by the patella ligament.

RELATIONS.—The internal and external divisions of the triceps (internal and external vastus) are for the most part covered only by the femoral aponeurosis and skin ; but the superior extremity of the former is crossed by the sartorial, and the corresponding part of the latter by the tensor of the fascia, and overlapped by the lower margin of the great gluteal muscle : the middle division (crureus) is covered throughout its whole extent entirely by the rectus. The inner border of the muscle is separated from the adductor group by a process of the femoral aponeurosis, and, in the middle third of the thigh, is in relation with the femoral artery, which lies here inclosed in a fibrous sheath, given off from this muscle and the long adductor. Its outer border is separated from the muscles upon the posterior femoral region by a strong process of the femoral fascia.

The name *subcrureus* or *capsular muscle* is sometimes applied to a few fleshy fibres situated beneath the middle division or crureus, of which they are a part. They are inserted into the highest point of the synovial membrane of the knee-joint, and their use is to keep the synovial membrane from folding and consequent bruising beneath the patella, in extension of the leg.

The *ligament of the patella* is the common tendon of the rectus and triceps extensor muscles of the leg, the patella itself being only a sesamoid bone. It is attached, above, to the anterior edge of the lower border of the patella, occupying about one-half or three-fourths of an inch of its extent, descends almost vertically, becoming somewhat narrower, and is inserted into the lower part of the tuberosity of the tibia. It is separated from the cavity of the knee-joint by a mass of fat and areolar tissue, and from the prominent point of the tuberosity over which it glides, by a large bursa, which is said sometimes to communicate with the articular synovial sac.

2. INTERNAL REGION OF THE THIGH.

The muscles situated upon the internal aspect of the thigh (with the exception of the gracilis, already described), act upon the thigh itself, and constitute the class of adductors. They are four, namely: the pectineus, long adductor, short adductor, and great adductor. Between these and the upper extremity of the sartorial, the continuation of the psoas and iliac muscles will be seen, which leave the cavity of the pelvis together beneath the crural arch, having the femoral artery and vein situated along the inner border of the femur, and the crural nerve upon the surface of the latter, and beneath the outer border of the psoas ; below the arch, their fibres converge downward and backward to a short, thick tendon, which glides over the prominent point of the small trochanter, a synovial bursa intervening, and is inserted into the back part of the root of this process.

The PECTINEUS MUSCLE (Fig. 176, 2), flattened from before backward, broad above, and narrow below, arises from the pubic part of the ilio-pectineal line, and the triangular surface of the body of the pubis in front of this line, between the spinous process of the bone and the ilio-pectineal eminence. It descends a little backward and outward, passes over the inner border of the hip-joint, and is inserted by a flat tendon, into the ridge leading from the small trochanter to the rough line of the femur.

USE.—To adduct the thigh, at the same time flexing it, and rotating it outward.

RELATIONS.—It is situated between the psoas and long adductor muscles, is covered above and externally by the femoral vessels and fascia, and lies upon the obturator vessels and nerves, external obturator and short adductor muscles, and the inner part of the capsular ligament of the hip-joint, to which latter it is somewhat firmly attached by areolar tissue.

The LONG ADDUCTOR MUSCLE (*adductor longus*, Fig. 176, 7), triangular, narrow above, and broad below, arises by a short, narrow, flattened tendon from the anterior surface of the pubic bone, between the spinous process and symphysis. It descends outward and backward, expanding into a broad, fleshy belly, and is inserted by a

short, broad, flat tendon, into the middle third of the rough line (*linea aspera*) of the femur.

Use.—Same as preceding.

Relations.—It is placed, *above*, between the gracilis and the pectineus, with whose inner border it is parallel, and apparently continuous; at its insertion it lies between the internal head (*vastus internus*) of the triceps extensor in front, and the great adductor behind, and is here crossed by the sartorial muscle, the femoral artery and vein and long saphenous nerve intervening; it lies upon the short adductor and a part of the great adductor. With the superior third of the sartorial and the crural arch it forms the femoral triangle, through the middle of which passes the femoral artery and vein.

Dissection.—Detach the long adductor from its origin, and turn it downward.

The short or small adductor muscle (*adductor brevis*) is situated beneath the preceding. It arises by a flat tendon from the anterior surface of the pubis, between the gracilis muscle and obturator foramen, expands into a thick, fleshy belly, and is inserted into the superior third of the rough line of the femur.

Use.—Same as two preceding.

Relations.—In *front*, it is in relation with the long adductor and pectineus; *behind*, with the great adductor; *externally*, with the external obturator, psoas, and iliac muscles; *internally*, first with the gracilis, and then with the great adductor, with which latter it is somewhat blended.

Dissection.—Detach the short adductor from its origin, and turn it downward and outward.

The great adductor muscle (*adductor magnus*), is situated between the three preceding and the muscles upon the back of the thigh. It is the longest and largest of the adductor group, narrow above, but very broad and thick below, and remarkable for the coarseness of its texture, the fleshy bundles being large, and separated from one another by areolar septa. It arises tendinous and fleshy from the anterior surface of the rami of the pubis and ischium, and tendinous from the external border of the ischiatic tuberosity. It descends, spreads out like a fan, and is inserted, by an aponeurotic expansion, into the whole length of the rough line (*linea aspera*) between its internal and external lips, and, by a long, rounded tendon, into a tubercle

upon the upper back part of the inner condyle of the femur. The fibres have different directions; those inserted into the upper part of the rough line reach nearly as high as the root of the great trochanter, and pass from their origin outward and a little upward. Below this they have different degrees of obliquity, and those which go to the inner condyle are nearly vertical. Between the last insertion and that into the rough line a considerable interval exists, through which the femoral artery and vein reach the popliteal space behind the knee-joint. The insertion into the rough line is blended with the attachments of the internal head of the triceps extensor, long adductor, and short head of the biceps flexor, and is perforated at three or four points for the passage of bloodvessels to and from the posterior part of the thigh.

Use.—Like that of the three preceding, its special function is to carry the thigh inward, but it may also act as an extensor when the thigh is much flexed, and as a flexor when extended; this last is, in fact, its most common action. When the thigh is the fixed point, it steadies the trunk upon the femur.

Relations.—In *front*, with the pectineus, long adductor, short adductor, and internal head of the triceps extensor; *behind*, with the biceps flexor, great gluteus, semitendinous and semimembranous muscles, and sciatic nerve; *by its inner border*, first with the gracilis, and then the sartorial; by its *superior border*, with the quadrate or square muscle of the thigh. Its most important relation, however, is with the femoral artery and vein, which, in the lower fourth of the thigh, pass between the two divisions of the insertion of the muscle to reach the ham or popliteal space.

The *vessels and nerves* seen in this dissection are, the femoral artery and vein, and crural nerve.

The *femoral artery* is the continuation of the iliac. It makes its appearance upon the thigh beneath the inner fourth of the crural arch, between the femoral vein and psoas muscle, about an inch and a quarter external to the concave edge of Gimbernat's ligament. From this point, it descends almost vertically to reach the popliteal space, the curvature of the femur inward requiring the vessel to incline but very little backward for this purpose. In the upper third of the thigh it passes vertically through the middle of the triangular space, marked off, *above*, by a line corresponding to the fold of the groin; *internally*, by the long adductor muscle, and *externally*, by the superior third of the sartorial. In this space it rests, first upon the inner border of the psoas, next the outer

border of the pectineus, and then the short adductor, which separate it from the head of the femur. It is covered by the skin, superficial fascia, and femoral aponeurosis. It is here that the vessel may be felt pulsating, and may be compressed either upon the pubis, or, lower down, upon the inner and anterior surface of the femur. Ligature of the artery is usually performed in the lowest angle of the triangle, for reasons hereafter to be mentioned. In the middle third of the thigh it lies upon the insertion of the long and great adductor behind, in contact with the inner border of the internal head (internal vastus) of the triceps, and covered in by the sartorial. It is contained, together with its accompanying vein and saphenous nerve, in a fibrous sheath formed from the tendinous fibres of the above-mentioned muscles, which are here attached to the rough line of the femur. Below this point, the artery and vein reach the popliteal space through a tendinous oval opening, situated upon the inner side of the femur in the interval, between the long tendon of the great adductor, and that portion of the muscle that is inserted into the rough line of the femur.

The branches of the femoral artery, which, however, will be more particularly studied upon the limb reserved for that purpose, are: 1, some small superficial twigs to the lymphatic glands of the groin, and skin of the scrotum, abdomen, and hip, named respectively, *external pudic* (superior and inferior), *superficial epigastric*, and *superficial circumflex iliac;* 2, a large branch called the *deep femoral* (*profunda*), to the muscles upon the inner and back part of the thigh; 3, muscular twigs to the sartorial, triceps, &c.; and 4, just before entering the popliteal space a considerable branch called the *great anastomotic* (*anastomotica magna*) to the parts about the inner side of the knee. Of these, the *deep femoral* is by far the most important; it comes off from the posterior aspect of the main trunk about two inches below the crural arch—often nearer—descends backward, and is divided into a great number of branches, some of which (the perforating arteries), perforate the insertion of the great adductor muscle to reach the back of the thigh, and others are distributed to the muscles around the hip-joint. It is the nearness of the origin of the deep femoral artery to the epigastric, which is given off from the external iliac just above the crural arch, that renders ligature of the common femoral artery dangerous in this part of the femoral triangle.

The *femoral vein*, while under the crural arch, lies to the inner side of the artery, but immediately below becomes posterior, and in

the popliteal space is even a little external. The *deep femoral* vein accompanies the artery of the same name, and opens into the preceding from behind, about two inches below the arch. The *internal saphenous* vein lies upon the femoral fascia, and terminates in the common femoral, by passing through the saphenous opening below the inner extremity of the crural arch.

The *Crural Nerve* leaves the abdomen beneath the crural arch, along the outer border of the psoas and upon the surface of the iliac muscle, and, having reached the thigh, divides almost immediately into a lash of branches, most of which are distributed to the muscles and skin of the anterior region of the thigh; one, however, called the *saphenous nerve*, longer than the rest, accompanies the femoral artery and vein within their common sheath, as far as the opening in the great adductor muscle, then passing between the tendons of the sartorial and gracilis muscles, it reaches the internal saphenous vein, whose course it follows along the inner side of the leg to the foot, distributing filaments at different points to the skin and muscles.

POSTERIOR PELVIC REGION.

The muscles situated upon the posterior and external surfaces of the pelvis are all movers of the thigh, and are divided into two groups—extensor and rotator. The extensor group comprises the three gluteal muscles; the rotator group consists of six—the pyriform, internal obturator, external obturator, superior twin, inferior twin, and square femoral. The extensors should be dissected first.

Dissection.—Turn the subject over, place a block transversely beneath the hips, and rotate the thigh inward; then make an incision from the point of the sacrum, following the fold of the buttock to the outer side of the thigh, another along the posterior half of the iliac crest, and a third from the superior iliac spine to the termination of the first. Dissect off first the skin and subcutaneous fat, which latter is generally very abundant in this region, and afterward the fascia that covers the first muscle of the extensor group—the great gluteal—following, as usual, the course of the muscular fibres. The fascia is a continuation of the femoral aponeurosis, is not however very dense, but very closely attached to the muscle by numerous prolongations, which dip into the substance of the muscle, and separate its coarse bundles from one another. On this account it is rather difficult to remove, for at every stroke of the knife a new process presents itself, until the whole are successively divided; and even when the greatest care has been taken, the muscle has nearly always a ragged, ill-dissected appearance.

The GREAT GLUTEAL MUSCLE (*gluteus maximus*, Fig. 178, 2) forms the prominent rounded part of the nates; it is very large, flattened, but very thick, and somewhat quadrangular in shape. It is remarkable for the coarseness of its texture, being composed of large muscular fascicles, which are separated from each other by prolongations of the investing fascia. It arises tendinous and fleshy from about two inches of the crest of the ilium behind, and the adjacent rough triangular surface upon the outer aspect of this bone; from the posterior sacro-iliac ligaments and the adjacent surface of the common aponeurosis of the spinal muscles; from the tubercles of the sacrum external to the posterior sacral foramina, and from the posterior surface of the coccyx and sacro-ischiatic ligament. From these points the fibres pass outward and downward, forming large angular bundles, nearly parallel, but slightly converging, and are inserted partly into the femoral aponeurosis, upon the outer aspect of the thigh, but principally by a broad, strong tendon, which glides over the great trochanter, into the rough ridge leading from the great trochanter to the rough line of the femur, also for a short distance into the upper part of this line.

USE.—To extend the thigh, and assist in rotating it outward. Acting from the femur, it is one of the principal muscles that maintain the body in an erect position.

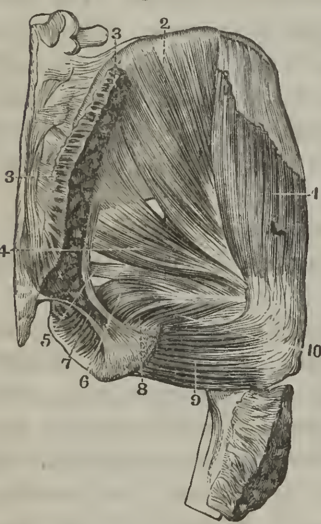
RELATIONS.—It is covered by an expansion of the femoral aponeurosis, and by firm areolar adipose tissue; it covers the posterior part of the middle gluteal muscle, all of the rotator group, the sacro-ischiatic foramina and their contained structures, the tuberosity of the ischium, the great trochanter, and the upper part of the external head (*vastus externus*) of the triceps. Its superior border is closely connected by the femoral aponeurosis to the surface of the middle gluteal muscle, which it crosses obliquely downward and forward. Its inferior forms a marked prominence across the upper back part of the thigh. A large multilocular bursa separates the tendon of the muscle from the trochanter, and sometimes a smaller one is found just below this, where the tendon passes over the upper part of the external head of the triceps; but between the muscular mass and the tuberosity of the ischium over which it lies, there is generally only a quantity of areolar tissue, which, however, in persons accustomed to sit much on hard seats, becomes converted into a true bursa.

DISSECTION.—Detach the great gluteal from its origins, and turn it outward, so as to examine its deep relations and insertion; then remove it

entirely, and dissect the areolar tissue, which is here very abundant, from the subjacent parts. In turning the muscle outward, branches of the gluteal artery, a vessel of considerable size, will be necessarily divided.

The MIDDLE GLUTEAL MUSCLE (*gluteus medius*, Fig. 177, 1, 2), broad, thick, and radiated, is more deeply seated than the preceding, but covered by it only, behind. It arises from the under surface of the femoral aponeurosis that covers its anterior half, and from the whole of the dorsal surface of the ilium between the anterior three-fourths of the crest above and the semicircular line below, extending as far forward as the superior anterior iliac spine and the subjacent notch, and as far backward as the margin of the sacro-ischiatic notch. From this extensive surface the fibres converge—those in front passing downward and backward, and those behind downward and forward—to a flattened tendon, which, passing over the prominent edge of the great trochanter, is inserted into the whole breadth of the outer surface of this process.

Fig. 177.



Muscles of the pelvic region. 1, 2, middle gluteal; 3, cut origin of the great gluteal; 4, pyriform; 5, 8, 10, superior and inferior twins (gemelli); 6, 7, internal obturator; 9, square femoral.

USE.—The special action of this muscle is extension of the thigh. It is also an abductor, and its anterior fibres rotate the femur inward. In the last movement (rotation inward) it acts almost entirely alone, the only other muscles from which it can possibly derive material assistance are, the tensor of the femoral aponeurosis, and the anterior fibres of the small gluteal.

RELATIONS.—It is covered behind by the great gluteal muscle, and in front by the femoral aponeurosis, from the under surface of which a large part of the muscle takes its origin. Its anterior border is overlapped by the tensor of the femoral fascia; its posterior is parallel, and in close contact with the pyriform; its deep surface covers the small gluteal muscle.

DISSECTION.—Detach the middle gluteal muscle from its origin, and turn it outward, taking care not to remove the pyriform along with it.

The SMALL GLUTEAL MUSCLE, much smaller, but shaped like the preceding, beneath which it is placed, arises from the whole space upon the dorsal surface of the ilium, between the curved line and acetabulum; its fibres descend convergingly, and end in a strong, flattened tendon, which is inserted into the anterior border and anterior half of the upper edge of the great trochanter.

USE.—Same as the preceding.

RELATIONS.—It is covered entirely by the middle gluteal, and lies upon the capsular ligament of the hip-joint.

The six muscles that rotate the thigh outward are now nearly all *in situ*, and in the same dissection will be observed numerous large arteries and nerves, presently to be mentioned.

The PYRIFORM MUSCLE (Fig. 177, 4), long, flattened, and triangular, originates by its broad extremity within the pelvis, from the anterior surface of the second, third, and fourth pieces of the sacrum external to the anterior sacral foramina; its fibres descend convergingly outward, and a little forward, through the upper part of the great sacro-ischiatic foramen, to a rounded tendon which is inserted into the inner surface of the upper border of the great trochanter behind.

RELATIONS.—By its anterior or internal surface it is in no relation with the rectum, sciatic plexus, hypogastric plexus, and, without the pelvis, with the hip-joint. Its posterior surface is in contact with the outer border of the sacrum, and covered by the great gluteal muscle. Its upper or external border is separated from the middle gluteal muscle above, and by the gluteal vessels and nerves, but below, is in intimate connection with this muscle. Its lower border is separated from the superior twin muscle by the great and small sciatic nerves and sciatic vessels. The great sciatic nerve often perforates the muscle.

The TWIN MUSCLES (*gemelli*, 5, 10) are two small, fleshy slips, connected with and separated from one another by the tendon of the internal obturator. The *superior* arises from the spine of the ischium, the *inferior* from the tuberosity; they both pass horizontally outward, and are inserted with the above tendon, which they closely embrace, into the digital fossa at the base of the great trochanter.

RELATIONS.—They are covered by the great gluteal muscle, crossed behind from above downward by the great sciatic nerve

and accompanying vessels, and in contact in front with the posterior surface of the hip-joint.

Dissection.—Divide the great sciatic nerve two or three inches below, and dissect the twin muscles off, to show the tendon of the internal obturator. The fleshy portion of this muscle has been already seen in the dissection of the interior of the pelvis.

The internal obturator muscle, flattened but thick, triangular in form, and situated partly within and partly without the cavity of the pelvis, arises from the internal surface of the obturator membrane and the borders of the obturator opening. The fibres converge downward and outward, toward the smaller sacro-ischiatic or sciatic foramen, where they end in a number of tendinous slips, which are reflected at a right angle over the pulley-like surface of the ischium between its spine and tuberosity, a large bursa intervening. These slips end in the rounded tendon, which is inclosed by the twin muscles, and inserted into the digital fossa at the root of the great trochanter. In order to see the tendinous slips and the smooth surface over which they glide, the tendon must be detached from its insertion and turned outward.

Relations.—Within the pelvis it lies anterior and external to the contained organs, and is covered by the tendinous arch that gives origin to the elevator muscle of the anus, and by the pelvic fascia. In leaving the cavity of the pelvis, it occupies the smaller sciatic foramen, in common with the internal pudic vessels and nerve; external to the pelvic cavity, it is covered by the great gluteal muscle, crossed by the great sciatic nerve and accompanying vessels, lies upon the posterior surface of the hip-joint, and is inseparably blended with the twin muscles.

The square femoral muscle (*quadratus femoris*, 9) is situated below the tendon of the preceding. It is flattened antero-posteriorly, quadrangular, as its name indicates, about two and a half inches long and one and a half broad, and almost entirely fleshy. It arises from the external border of the ischiatic tuberosity, passes transversely outward, and is inserted into the posterior border of the great trochanter and posterior inter-trochanteric line.

Relations.—It is covered by the great gluteal muscle, crossed by the great sciatic nerve and accompanying vessels, and covers the external obturator muscle and the posterior surface of the hip-joint. Its lower border is parallel and in contact with the superior border of the great adductor muscle, of which it often seems to be a part.

Dissection.—Detach the square muscle from its origin and insertion, and dissect off the subjacent areolar tissue, and the external obturator will be brought into view.

The external obturator muscle is triangular pyramidal, with its base presenting toward the pelvis, and thinner and smaller than the internal obturator. It arises fleshy from the anterior or external surface of the obturator membrane, and the adjoining surfaces of the bones that form the obturator foramen. The fibres converge outward and backward, to a fleshy belly, which turns obliquely around the neck of the femur, in a sort of notch, between the tuberosity of the ischium and acetabulum. Here a strong tendon is formed, which passes horizontally outward, between the inferior twin muscle and the capsular ligament of the hip-joint, and is inserted into the lowest part of the digital fossa, at the root of the great trochanter.

Relations.—It is covered anteriorly by the adductor, psoas, and iliac muscles, and obturator nerve and vessels; externally, by the capsular ligament and neck of the femur; and posteriorly, by the square and inferior twin muscles.

The special *action* of the preceding six muscles is rotation of the thigh outward. It is necessary, however, for the performance of this movement, that the limb should be either straight or extended; for when semi-flexed, as in the sitting posture, they are only abductors. Acting from the femur as a fixed point, they turn the trunk toward the opposite side. Some of them are closely connected with the capsular ligament of the hip-joint, and thus probably prevent the folding of this structure between the head of the bone and margin of the acetabulum.

The *arteries* observed in dissecting the posterior pelvic region, are: 1, the *gluteal artery*, a vessel of considerable size, which passes out the highest part of the great sacro-ischiatic foramen, and divides into branches, to supply the three gluteal muscles; 2, the *sciatic artery*, but little smaller than the gluteal, emerges at the lower part of the great sciatic foramen, in company with the great sciatic nerve, and is distributed to the muscles upon the lower back part of the hip and upper back part of the thighs; 3, the *internal pudic artery*, leaves the pelvic cavity at the lower part of the great sciatic foramen, passes over the posterior surface of the spine of the ischium, and enters the cavity again through the small sciatic foramen, to reach the deep part of the perineum and root of the penis. *Veins* accompany the several arteries, and terminate in the internal iliac vein. The *Nerves* are: 1, the *superior gluteal nerve*, which

accompanies the gluteal artery, and is distributed principally to the middle and small gluteal muscles; 2, the *inferior gluteal*, which emerges from the pelvis beneath the pyriform muscle, and is distributed to the great gluteal muscle; 3, the *small sciatic* originates by a common trunk with the preceding, passes from the pelvis beneath the pyriform muscle, and is distributed principally to the skin, over the tuberosity of the ischium and back of the thigh; 4, the *pudic* accompanies the internal pudic artery and its branches; 5, the *great sciatic*, the largest nerve in the body, leaves the pelvic cavity beneath the pyriform muscle, and descends upon the twin, internal obturator, and square muscles, midway between the great trochanter and tuberosity of the ischium, to the back of the thigh, whence it descends to the leg and foot, as will be hereafter seen.

POSTERIOR FEMORAL REGION.

The muscles situated upon the back of the thigh are the biceps, semitendinous, and semimembranous. They are commonly called the ham-string muscles, and are all flexors of the leg. The popliteus, the other muscle belonging to the flexor group, is situated upon the back of the leg.

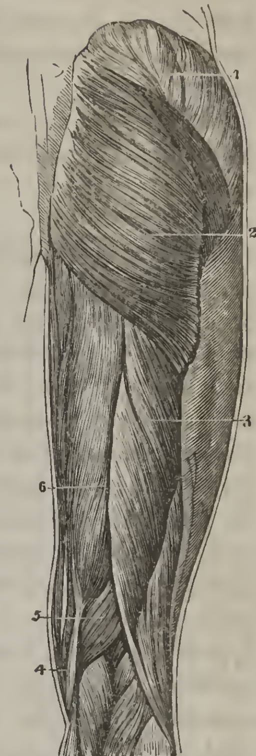
DISSECTION.—Divide the skin by an incision extending from the ischiatic tuberosity to the middle of the lower part of the ham, where it may be intersected by another, extending transversely across the upper back part of the leg. Dissect aside the skin and subcutaneous cellulo-adipose tissue, and the continuation of the femoral aponeurosis that covers the muscles of this region will be brought into view. This aponeurosis or fascia is not nearly so dense as upon the outer or anterior aspect of the limb, but increases in strength from above downward. It is attached above to the tuberosity of the ischium, dips down upon each side to reach the rough line of the femur, sends processes or sheaths to the subjacent muscles, and is continuous, below the ham, with the fascia of the leg.

Turn aside the fascia, and dissect the areolar and adipose tissue cleanly from the muscles and popliteal space.

The BICEPS FLEXOR MUSCLE OF THE LEG (Fig. 178, 3), a long large muscle, situated upon the outer back part of the thigh, has, as its name indicates, two heads, of which one is longer than the other. The *long head* originates from the upper back part of the tuberosity of the ischium by a thick, strong tendon, common to it and the semitendinous muscle, descends a little outward, leaves

the latter muscle about two or three inches below the tuberosity, expands into a fusiform, fleshy belly, and at the inferior third of the thigh unites with the *short head*, which arises fleshy from the middle three-fifths of the rough line of the femur, and descends backward and a little inward, in the form of a rounded fleshy mass. The two form a common strong tendon (the external hamstring), which descends behind the outer side of the knee, turns forward, and is inserted into the head of the fibula, and by an aponeurotic expansion into the head of the tibia and crural fascia.

Fig. 178.



Muscles of the back of the thigh: 1, middle gluteal; 2, great gluteal; 3, biceps flexor of the leg; 4, tendon of semitendinous; 5, semimembranous; 6, semitendinous.

USE.—To flex the leg, and, secondarily, to extend the thigh. Acting from the leg as a fixed point, it steadies the thigh and pelvis, and bends the latter backward upon the hip-joint.

RELATIONS.—The common tendon of the biceps and semitendinous muscles is covered by the great gluteal muscle, and separated from the tuberosity of the ischium by a bursa; from the point where the two separate, the long head lies, at first, upon the posterior surface of the semitendinous, but gradually leaves it to the inner side, and passes over the great sciatic nerve, and short head; the common tendon of the two heads crosses the external articular vessel, and external head of the gastrocnemius muscle.

The SEMITENDINOUS MUSCLE (6) arises from the upper back part of the tuberosity of the ischium, by a common tendon, with the biceps; the muscular fibres originate from the outer side of the tendon for the distance of two or three inches, and form a large fusiform belly, which descends a little outward, and about three inches above the knee-joint terminates in a long rounded tendon; this passes behind the internal condyle of the femur, turns around the internal tuberosity of the tibia, and is inserted into the anterior tuberosity of the tibia, behind the tendon of the sartorial, and be-

low that of the gracilis; the lower or convex edge of the tendon is connected with the fascia of the leg.

USE.—To flex the leg and rotate it slightly inward; or, acting from the leg, to steady the pelvis on the hip-joint, and bend it backward; as a secondary effect, it may assist in flexing the thigh on the pelvis.

RELATIONS.—It is covered superiorly by the great gluteal muscle, is superficial in the rest of its course, and rests upon the semimembranous.

The SEMIMEMBRANOUS MUSCLE, situated beneath the preceding, arises from the upper back part of the tuberosity of the ischium, beneath the common origin of the biceps and semitendinous, by a strong flat tendon, which descends and spreads out into an aponeurotic lamina; from the inner surface of this lamina, the fleshy fibres originate as low down as the middle third of the thigh, and pass obliquely inward to the outer surface of a corresponding lamina below, which descends, narrows to a thick tendon that passes behind the internal condyle of the femur, and divides into three parts; one of these divisions, broad and thin, is reflected upward and backward beneath the internal head of the gastrocnemius, and across the posterior surface of the knee-joint, to be inserted into the external condyle of the femur, constituting what is commonly called *Winslow's ligament*, or the *posterior ligament* of the knee-joint; another, also aponeurotic, expands over the popliteus muscle to be inserted into the posterior surface of the head of the tibia; and the third turns forward beneath the internal lateral ligament of the knee-joint, and is inserted into the inner tuberosity of the tibia, behind the insertion of the gracilis and semitendinous.

USE.—To flex the leg and rotate it inward, and secondarily, to extend the thigh; when the leg is the fixed point, it steadies the trunk upon the femur, and assists in bending it backward at the hip-joint.

RELATIONS.—It is covered above by the semitendinous, biceps, and great gluteal muscles, and crosses the great adductor and square muscles; below, it is superficial, external to the semitendinous, overlaps the popliteal vessels, and is parallel with the great sciatic nerve which lies along its outer border.

Upon the back of the thigh, between and beneath the preceding three muscles, is a long narrow cellular interval, communicating, above, with the pelvis at the great sciatic foramen, and below, with the popliteal space or ham of the leg. This interval is traversed

its whole length by the great sciatic nerve, surrounded by an abundance of loose areolar tissue, and is the track along which purulent matter sometimes travels, from the cavity of the pelvis or upper back part of the thigh, to the popliteal space.

No very large or important bloodvessels are seen in this dissection. We have here, however, the *great sciatic nerve*, covered successively from above, downward, by the great gluteal, biceps, and semitendinous muscles, and resting upon the posterior surface of the square and great adductor muscles as far as the popliteal space. In its course, this nerve gives off several cutaneous and muscular twigs, and in the lower third of the thigh splits into two branches, one of which, called the *tibial* or *popliteal nerve*, continues straight on through the popliteal space to the back of the leg; and the other, the *peroneal nerve*, turns around the outer side of the knee, and crosses the upper extremity of the fibula to reach the front of the leg. This bifurcation of the sciatic nerve frequently occurs much higher up, and sometimes even within the pelvis. In the latter case, the two divisions either emerge together beneath the pyriform muscle, or one passes below, and the other above or through its substance. In either case, the two follow the same course to the popliteal space, lying side by side, and separated only by a narrow cellular interspace.

The *popliteal space* or pit of the ham, is the large diamond-shaped interval, situated upon the back part of the lower extremity of the femur and the knee. It is formed principally by the divergence of the biceps or external hamstring muscle on one side, and the semitendinous and semimembranous or internal hamstring muscles on the other, and is, therefore, situated mostly above the knee-joint; its inferior short angle is formed by the two heads of the gastrocnemius muscle, which arise from the corresponding condyles of the femur internal to the hamstring muscles, and unite about an inch below the joint. The space is covered in by the skin and a continuation of the femoral aponeurosis, and contains an abundance of cellulo-adipose tissue, the popliteal artery and vein, the tibial and peroneal nerves, and three or four lymphatic glands. The nerves are superficial and external to the vessels; the artery, which is the continuation of the femoral, lies close to the bone nearly in the middle line, but inclines from above downward and a little outward; the vein is less deep-seated than the artery, along the outer border of which it is placed, and to which it is very closely adherent.

28

MUSCLES OF THE LEG.

The muscles of the leg consist of three groups, of which one is anterior, one external, and the third posterior. The anterior group comprises three muscles, the anterior tibial, the extensor of the great toe, and the long common extensor of the toes; these are situated upon the anterior crural region, between the tibia and fibula, and upon the interosseous membrane, and should be dissected first.

Dissection of the anterior crural region.—First detach the limb from the pelvis by cutting through the coxo-femoral articulation, and remove all of the muscles from the femur, dividing those that are attached to the leg, within two or three inches of their insertion; then divide the skin by a long incision, extending from the anterior tuberosity of the tibia, along the external border or spine of this bone to the ankle, and thence along the inner margin of the top of the foot to the extremity of the great toe; reflect the skin outward as far as the external border of the leg and foot, so as to expose the subjacent aponeurosis or fascia.

The *crural aponeurosis* of the anterior region is tolerably dense and strong, continuous above with the aponeurosis of the thigh, and with the tendons of the sartorial, gracilis, semitendinous, semimembranous, and biceps muscles, and is attached, above, to the head of the fibula and tibia. From these points it descends upon the front of the leg, having a close attachment to the spine of the tibia, and to the origins of the anterior muscles; becoming thinner as it descends, it spreads out over the muscles of the fibular region to reach the back of the leg, and, increasing in density at the ankle, forms what is called the *anterior annular ligament* (Fig. 179). This ligament, often but improperly considered a separate structure, is attached, internally, to the malleolar process of the tibia and the navicular bone, and, externally, to the external malleolus and upper part of the heel-bone. It binds the tendons of the anterior tibial and two extensor muscles in their places; and from its under surface two processes, attached to the ligamentous structures about the joint, are given off to form three separate sheaths, for the accommodation of the tendons. Upon the upper or dorsal surface of the foot the fascia is thin and comparatively weak, and attached, externally and internally, to the bones forming the corresponding borders of the foot.

Dissection.—Divide the fascia just above the ankle so as to leave an annular band; cut it also from the spine of the tibia its whole length, and reflect it outward. In doing this, it is necessary to carry the edge of the

knife close to its under surface in the upper part of the region; for here, as before mentioned, it is closely attached to the subjacent muscles; in fact, the muscles partly originate from its under surface.

The ANTERIOR TIBIAL MUSCLE (*tibialis anticus*, Fig. 179, 6) is long and tapering, and situated in front of the leg along the outer surface of the tibia. It arises fleshy, from the tuberosity and upper two-thirds of the outer surface of this bone, from the adjacent part of the interosseous membrane, and from the under surface of the crural fascia above. It descends almost vertically, and in the lower third of the leg, terminates in a long and somewhat flattened tendon, which passes through a separate ring beneath the annular ligament, inclines inward over the forepart of the lower extremity of the tibia, crosses the astragalus and scaphoid bones, and is inserted into the inner side of the large cuneiform bone, and the contiguous end of the first metatarsal bone.

USE.—To flex the foot, also to adduct it and raise its inner border; acting from the foot, it steadies the leg at the ankle-joint.

RELATIONS.—It is covered throughout its whole length by the crural fascia, and lies upon the outer surface of the tibia in the upper two-thirds of its extent, and below, upon the anterior surface of this bone; externally, it is in contact with the long extensor of the toes, and extensor of the great toe, the anterior tibial vessels and nerve intervening, but situated deep upon the anterior surface of the interosseous membrane.

The LONG EXTENSOR MUSCLE OF THE TOES (*extensor longus digitorum pedis*, Fig. 179, 7) is long, thin, flattened from side to side, and external to the preceding. It arises fleshy, from the upper two-thirds of the anterior surface of the fibula, from the interosseous membrane, and from the crural fascia, and terminates just above the ankle in three tendons which pass beneath anterior annular ligament. On the top of the foot the external tendon splits into two, making the whole number four; these proceed toward the toes, at the base of which they are joined by the tendons of the short extensor, and, forming a fibrous expansion over the first phalanges, they are inserted into the bases of the second and third phalanges. Before reaching the toes, the tendons are connected together by little fibrous slips that proceed from one to another.

USE.—To extend the toes, and secondarily, to flex the foot; acting from the foot, it assists in steadying the leg at the ankle-joint.

Relations.—It is covered by the crural fascia, and is in contact, internally, with the anterior tibial and extensor of the great toe; externally, with the peroneal muscles, the shortest one of which seems to be only an offset from the extensor; its tendons cross those of the short extensor upon the upper surface of the foot, obliquely, from within outward.

Fig. 179.

Muscles of the anterior crural region. 1. Biceps flexor of the leg. 2. External head of the triceps. 3, 3. Gastrocnemius. 4. Soleus. 5. Achilles's tendon. 6. Anterior tibial. 7. Long extensor of the toes. 8. Extensor of the great toe. 9. Small peroneal. 10. Long peroneal. 11. Short peroneal. 12. Adductor of the small toe. 13. Short extensor of the toes.

The extensor muscle of the great toe (*extensor proprius pollicis pedis*, Fig. 179, 8) is long, narrow, flattened laterally, and situated between the two preceding. It arises fleshy, from the middle third of the internal surface of the fibula, and from the interosseous membrane; it descends as far as the ankle, where it terminates in a long, narrow tendon, which, passing beneath the anterior annular ligament and along the upper surface of the foot, spreads out into an aponeurosis over the first joint of the great toe, and is inserted into the base of its second phalanx.

Use.—To extend the great toe, and secondarily, to assist in flexing the foot.

Relations.—On the leg, it lies between the two preceding muscles, and external to the anterior tibial artery, but, on the upper surface of the foot, it is placed to the inner side of this vessel, having crossed it obliquely just below the ankle-joint.

The short extensor muscle of the toes (*extensor brevis digitorum pedis*, 13), although belonging to a different region from the three preceding muscles, is necessarily exposed by the same dissection, and may as well be studied in this connection. It is situated upon the upper surface of the foot, and consists of a broad, thin, fleshy layer, which arises from the superior surface of the heel-bone and calcaneo-astragalous ligament, passes forward and a little inward, and terminates in four small tendons, which become con-

tinuous with the tendons of the long extensor at the base of the toes.

Use.—To assist in extension of the toes.

Relations.—Superficially, it is in relation with the tendons of the long extensor, the two sets crossing obliquely ; by its deep surface, with the bones and ligaments of the foot.

The *anterior tibial artery* is a branch of the popliteal, and makes its appearance upon the front of the leg, at the upper part of the interosseous space, having perforated the interosseous membrane in this situation, in company with two veins. It descends, lying at first between the anterior tibial, and the long, common extensor muscles, in the middle of the leg, between the former and the extensor of the great toe, and inferiorly, between the tendon of the latter and that of the long common extensor. It is at first deep seated, and rests upon the anterior surface of the interosseous membrane, but, as it descends, gradually approaches nearer the surface, and just before reaching the ankle, it lies obliquely across the anterior surface of the lower extremity of the tibia ; it then crosses the ankle-joint behind the annular ligament, passes obliquely beneath the tendon of the extensor muscle of the great toe, and, continuing its course forward under the name of the *dorsal* artery of the foot, reaches the space between the first and second metatarsal bones, at the back part of which it dips down to join the plantar arch upon the bottom of the foot.

The *peroneal* or *fibular nerve*, also seen in this dissection, reaches the front of the leg by winding around the upper extremity of the fibula ; here, it gives off numerous branches to the muscles and skin upon the outer part of the leg, but its main trunk continues on obliquely, forward and downward, to reach the outer side of the anterior tibial artery, which it accompanies to the foot.

The peroneal or fibular group of muscles, consists of three, named from their situation and relative size, the long, short, and small peroneal.

Dissection of the external crural region.—Reflect the flap of skin, which has been already taken from the anterior surface of the leg, farther outward, and observe the disposition of the crural fascia, especially at the ankle-joint, where it stretches across from the external malleolar process to the heel-bone, forming what is called the *external annular ligament*, and confining the tendons of the long and short peroneal muscles. Just above the ankle, the fascia is perforated by several cutaneous branches of the peroneal nerve. Next, dissect the fascia from the surface of the muscles, leaving the annular ligament in its place.

The long peroneal muscle (*peroneus longus*) (Fig. 179, 10),

long and narrow, and tendinous in the lower half of its extent, arises fleshy, from the upper two-thirds of the external surface of the fibula, from the adjacent tuberosity of the tibia, and from the aponeurotic septa which separate the muscles of this region from those on the anterior and back of the leg. It descends vertically, and in the lower third of the leg terminates in a long tendon, which passes in a groove behind the malleolar process of the fibula, occupying a sheath beneath the external annular ligament in common with the short peroneal muscle, then turns beneath the outer border of the foot, runs along a groove in the under surface of the cuboid bone; next, makes a turn forward and inward across the bottom of the foot, and is inserted into the base of the first metatarsal bone. Its course beneath the foot cannot be seen until the dissection of this region.

Use.—To extend the foot and erect its lower surface; the latter action is not very evident in the natural state of the parts, but in fracture of the lower extremity of the fibula, the check to the movement of the ankle in this direction being thus in a great measure removed, it is very remarkable; acting from the foot, especially in standing on one foot, it prevents the weight of the body from inclining the leg inward.

Relations.—It is covered by the skin and fascia of the leg, and lies upon the short peroneal muscle and upper part of the bone between the muscles of the anterior and posterior regions; in the sole of the foot it is placed in contact with the bones, and consequently above all the muscles of this region.

The short peroneal muscle (*peroneus brevis*), exposed by the removal of the preceding, arises fleshy from the lower half of the external surface of the fibula and the intermuscular fascia on each side, descends vertically, and terminates, just above the external malleolus, in a flattened tendon which passes behind this process in the same groove and sheath with the preceding muscle, turns forward, passes through a special groove in the heel-bone, and is inserted into the base of the last metatarsal bone (11).

Use.—To extend the foot and to assist slightly in erecting it; acting from the foot it assists the long peroneal in steadying the leg at the ankle joint.

The small peroneal muscle (*peroneus tertius*) is intimately connected with the extensor muscle of the toes, of which it is often

considered as an offset. It arises fleshy from the lower third of the forepart of the fibula and adjacent surface of the interosseous membrane, descends, and terminates in a small tendon which passes beneath the anterior annular ligament in common with the tendons of the long extensor of the toes, and is inserted into the base of the fifth metatarsal bone. Sometimes it is inserted into the fourth metatarsal bone, and sometimes it is wanting.

Use.—To flex the foot and assist slightly in its eversion.

The muscles upon the back of the leg form a superficial and a deep group, each consisting of three muscles. The three *superficial* are the gastrocnemius, soleus, and plantaris; the *deep* are the posterior tibial, common flexor of the toes, and proper flexor of the great toe. This grouping of the muscles of the leg into threes, will greatly aid the student in remembering their relative position. As he has already seen, the anterior tibial group consists of three, the anterior tibial, long extensor of the toes, and proper extensor of the great toe; the fibular or peroneal group of three, the long, short, and small peroneal muscles; and the posterior tibial group is subdivided into a superficial and deep, each consisting of three, as above mentioned.

Dissection of the back of the leg.—The skin having been already removed from the front and outer surface of the leg, may be dissected from the posterior surface by turning it from either one side or the other, as far down as the inner side of the foot, so as to expose the fascia of this region, and the main trunk of the external or short saphenous vein.

The *short saphenous vein* lies upon the surface of the fascia. It commences behind the ankle externally by the junction of several small branches from the heel and bottom of the foot, ascends a little inward, receiving several branches in its course, and perforates the fascia in the lower part of the popliteal space to reach the popliteal vein into which it opens. The *fascia* or aponeurosis upon the back of the leg is thin, and blended near the heel with the subjacent areolar tissue and the fascia that covers the deep group of muscles. Upon the inner side of the ankle it forms a broad and tolerably thick band called the *internal annular ligament*, which stretches from the malleolar process of the tibia to the lower back part of the heel-bone (*os calcis*), forming an arch in this situation beneath which pass the tendons of the deep muscles, and the posterior tibial vessels and nerve; above, it is continuous with the femoral aponeurosis over the popliteal space, and on each side, with the fascia that separates the superficial from the deep muscles. About midway between

the knee and heel, the fascia is perforated by the short saphenous vein, which here joins the popliteal vein and descends with it to be distributed to the skin upon the outer side of the ankle and foot, some of its filaments reaching as far as the little toe.

Fig. 180.

The superficial muscles of the posterior aspect of the leg. 1. The biceps muscle forming the outer hamstring. 2. The tendons forming the inner hamstring. 3. The popliteal space. 4. The gastrocnemius muscle. 5. The soleus. 6. Achilles's tendon. 7. The posterior tuberosity of the heel-bone. 8. The tendons of the long and short peroneal muscles passing behind the outer ankle. 9. The tendons of the posterior tibial and long flexor of the toes passing into the foot behind the inner ankle.

Dissection.—Remove all the fascia except where it constitutes the internal annular ligament, and the posterior surface of the gastrocnemius muscle, and Achilles's tendon will be brought into view.

The gastrocnemius muscle, so called because it forms the greater part of the calf of the leg (γαστηρ, a *belly*, and κνημη, the *leg*), broad and thick, arises from the lower back part of the femur, just above its condyles, by two separate tendinous heads, which form the lower boundary of the popliteal space, and descending, become spread out into a glistening aponeurosis. From the under surface of these expanded tendons, the muscular fibres proceed downward and forward, constituting two large distinct fleshy bellies, and are inserted into the posterior surface of a broad aponeurosis, which narrows as it descends, and having united with the soleus muscle, is inserted through Achilles's tendon into the lower back part of the heel-bone. The gastrocnemius is covered by the crural fascia, and has lying upon the middle of its superficial surface, between the two fleshy bellies, the short saphenous vein and nerve; it covers in the plantaris, soleus, and popliteal muscles; its two heads are inclosed by the hamstring muscles, the external one is crossed by the peroneal nerve, and the two, separated by the popliteal vessels and posterior tibial nerve, are in contact with the condyles, a synovial bursa generally intervening.

A sesamoid fibro-cartilage is frequently present in one or other of the two heads where it plays over the condyle.

Dissection.—Detach the two heads of the gastrocnemius and turn the muscle down, taking care not to raise along with it the plantaris, the small fleshy belly of which is in close contact with the external head.

The SOLEUS MUSCLE, broad, thick, and oval, arises by tendinous fibres from the superior third of the posterior surface of the fibula, from the lower edge of the oblique ridge on the posterior surface of the tibia, and about two inches of this surface below the ridge, and from a tendinous arch stretched between the two bones for the protection of the posterior tibial vessels and nerve; the fibres descend slightly backward, soon become fleshy, and terminate upon the deep surface of a broad aponeurosis, which narrows from above downward, and in the lower part of the leg joins the gastrocnemius to form Achilles's tendon. The muscle continues fleshy lower than the gastrocnemius, is completely covered by the latter, except a little strip on each side just above the tendon.

*Achilles's tendon** (*tendo Achillis*), formed by the union of the tendons of the gastrocnemius and soleus muscles, is the strongest and thickest tendon in the body. It is about two inches long, broad, and thin above, thick and contracted in the middle, and expanded again below, and inserted into the tuberosity of the heel-bone, a synovial bursa intervening between the upper part of the bone and the back part of the tendon. It is covered by the fascia and skin, and separated from the deep muscles and vessels by a considerable interval occupied by fat and areolar tissue. Its comparatively isolated position renders its division, for the cure of club-foot, easy and free from danger.

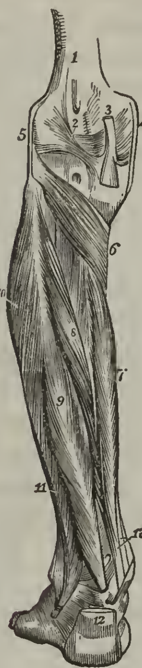
The PLANTARIS MUSCLE consists of a small, pyriform, fleshy belly, about two inches long, and a very long, delicate tendon. It arises from the femur, immediately above the external condyle, descends behind the corresponding head of the gastrocnemius, and terminates in its long, narrow tendon, which descends between the gastrocnemius and soleus, inclining a little inward, and, having gained the inner border of Achilles's tendon, continues in this connection to the heel-bone. It sometimes terminates in Achilles's tendon, and is often wanting.

The gastrocnemius and soleus are among the most powerful muscles in the body. Their special action is to extend the foot, in doing which, the foot remaining on the ground, as in walking or standing on tip-toe, they raise the whole weight of the body. They

* Called after Achilles, whose mother is related to have taken him by this part of the leg, and dipped him in the River Styx, thus rendering his body invulnerable except the part grasped by her fingers.

are brought powerfully into action in running, jumping, dancing, &c., and, in violent efforts, have been known not unfrequently to rupture Achilles's tendon, or to tear away the back part of the heel-bone. In addition to its action on the foot, the gastrocnemius may, in a secondary manner, be made to assist in flexing the leg. Acting from the foot, they both steady the leg at the ankle-joint, and the gastrocnemius assists in steadying the femur at the knee-joint. The plantaris is an accessory to the gastrocnemius, but comparatively of little force.

Fig. 181.



Deep muscles of the posterior tibial region. 1. The lower extremity of the femur. 2. Ligament of Winslow. 3. Tendon of the semimembranous muscle. 4. Internal lateral ligament of the knee-joint. 5. External lateral ligament. 6. Popliteal muscle. 7. Long flexor of the toes. 8. Posterior tibial muscle. 9. Long flexor of the great toe. 10. Long peroneal muscle. 11. Short peroneal. 12. Achilles's tendon divided near its insertion. 13. Tendons of the posterior tibial and long flexor of the toes, just as they are about to pass beneath the internal annular ligament. The interval between the latter tendon and the tendon of the long flexor of the great toe, is occupied by the posterior tibial vessels and nerve.

The POPLITEAL MUSCLE (Fig. 181, 6) is situated upon the upper back part of the leg, beneath the gastrocnemius, but belongs with the semimembranous, biceps, &c., to the group of flexors of the leg. It is flat and triangular, arises by a thick tendon nearly an inch long from a small pit upon the outer surface of the external condyle of the femur, passes obliquely downward and inward, in close contact with the knee-joint, spreads out, and is inserted into the triangular surface of the tibia, above the oblique line.

USE.—To flex the leg and rotate it inward, but mainly to strengthen the knee-joint.

RELATIONS.—It is covered by a strong fibrous expansion from the tendon of the semimembranous, which separates it from the gastrocnemius. Its tendon is attached to the external semilunar cartilage of the knee-joint, which is sometimes grooved for its accommodation; it is invested internally by the synovial membrane, and crossed externally, near its origin, by the external lateral ligament.

The *deep group* of muscles upon the back of the leg consists of the long flexor of the toes, the long flexor of

the great toe, and the posterior tibial. They are covered by a thin fascia stretched between the two bones, continuous above with the fascia that covers the popliteal muscle, and below with the internal annular ligament. To expose them, it is only necessary to detach the soleus and gastrocnemius, and dissect off the intermuscular fascia. Their insertions, however, take place upon the bottom of the foot, and cannot at present be seen.

The LONG FLEXOR MUSCLE OF THE TOES (*flexor longus digitorum pedis*, Fig. 181, 7) arises fleshy from the posterior surface of the tibia, from a short distance below the oblique line, to within two or three inches of the ankle-joint, and from the adjacent part of the interosseous membrane; the fibres descend backward to a tendon situated forward upon the posterior aspect of the muscle, which passes behind the malleolar process of the tibia in a groove with the tendon of the posterior tibial muscle, and beneath the internal annular ligament, then turns forward along a groove on the astragalus and heel-bone, and about the middle of the sole of the foot, splits into four terminal tendons. These pass to the four smaller toes, beneath which they perforate the tendons of the short flexor, which are split for the purpose, and traversing a fibrous sheath formed upon the under surface of the first and second phalanges of each toe, they are inserted into the bases of the last phalanges. In its course through the sole of the foot, the tendon receives upon its outer side an accessory muscular mass originating from the heel-bone, and crosses, beneath the tendon of the flexor of the great toe, a tendinous slip connecting the two.

USE.—To flex the phalanges of the toes, and, secondarily, to extend the foot. In this it is assisted by the accessory muscle, which is connected to its tendon in the bottom of the foot, and by "correcting its obliquity diminishes its tendency to invert the foot in extending the ankle-joint."

The pedal portion of this muscle, as well as that of the others of this group, cannot be seen until the foot is dissected.

The LONG FLEXOR MUSCLE OF THE GREAT TOE (*flexor longus pollicis pedis*) arises fleshy from the lower two-thirds of the posterior surface of the fibula, from a small part of the interosseous membrane, and from the intermuscular septa. A tendon is formed upon the posterior surface of the muscle, descends along a separate groove upon the posterior surface of the internal malleolus,

external to that occupied by the posterior tibial and preceding muscles, turns forward, runs along a groove upon the astragalus and tubercle of the heel-bone, crosses above the tendon of the long flexor of the toes, passes along the under surface of the first metatarsal bone, between the two heads of the short flexor, and having traversed a vaginal sheath which binds it to the inferior surface of the first phalanx, is inserted into the bone of the second.

USE.—To flex the great toe, and assist in extending the foot.

The POSTERIOR TIBIAL MUSCLE (*tibialis posticus*, 8) is situated upon the back of the leg, between the two preceding, and is divided at its superior extremity into two short lateral slips, between which the anterior tibial vessels perforate the interosseous membrane, to reach the front of the leg. It arises fleshy from nearly the whole length of the posterior surface of the interosseous membrane, the adjacent borders of the fibula and tibia, and the intermuscular septa, and terminates below in a strong tendon, which traverses a groove upon the posterior surface of the internal malleolus in common with the long flexor of the toes, crosses above this tendon, and proceeds, forward and inward, to be inserted into the inferior and internal part of the scaphoid and internal cuneiform bones.

USE.—To extend the foot.

MUSCLES OF THE FOOT.

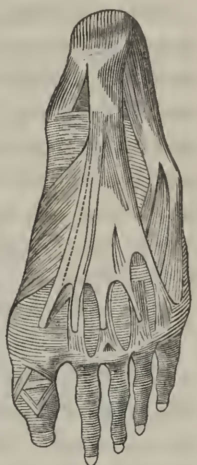
There are nineteen different muscles in the region of the foot (see classification, page 413), all of which, with the exception of the short extensor of the toes, are situated upon the plantar surface and between the metatarsal bones. Although very interesting in a physiological point of view, they possess but little practical importance, and the student is advised not to spend much time in their dissection, nor to burden his mind with the recollection of the details of their origin and insertion, unless his object is to become an accomplished anatomist. Still, he should not neglect to dissect this region with some care, for, besides the general knowledge he may obtain of the relative position of the different parts, he has yet to see the insertions of several of the muscles of the leg already described.

DISSECTION OF THE PLANTAR SURFACE OF THE FOOT.—Commence upon either border of the foot, and carefully remove the skin and the subcutaneous

layer of dense cellulo-adipose tissue intervening between it and the plantar aponeurosis. The thickness of this adipose layer varies according to the general condition of the body, but it is never entirely wanting, even in the most emaciated persons, and is remarkable for its firmness, and the great strength of the areolar processes or bands which traverse it, and are connected to the skin and subjacent aponeurosis. To dissect this layer clean from the surface of the aponeurosis requires much care and perseverance.

The PLANTAR APONEUROSIS is a thick, strong, fibrous membrane, covering the muscles of the bottom of the foot, irregularly triangular in shape, narrow behind, where it is attached to the under surface of the heel-bone, and expanded in front over the ball of the foot. It consists of three divisions; an *internal*, which is thin, covering the abductor muscle of the great toe, and liable to be removed along with the skin; an *external*, thick and strong, covering the corresponding border of the foot; and a *central* portion situated between the two. It is continuous on each side with the fascia of the dorsal surface of the foot, covered below by the dense, subcutaneous, adipose layer, and intimately connected by its upper surface with some of the muscles of this region. Its anterior expanded extremity reaches as far as the roots of the toes, and opposite them it is divided into as many processes, each of which splits for the passage of the flexor tendons. The two bundles of fibres resulting from this last division pass to the corresponding sides of the metatarso-phalangeal articulation, and become blended with the ligaments in this situation. It also sends three longitudinal processes from its upper or deep surface, which are attached to the bones of the foot, and separate the outer, middle, and internal divisions of this region from one another.*

Fig. 182.



The Plantar Aponeurosis.

DISSECTION.—Remove the plantar aponeurosis, by turning it from before backward, taking care to carry the knife close to its under surface, since some of the muscles take their origin partly from this surface behind.

The SHORT FLEXOR MUSCLE OF THE TOES (*flexor brevis digitorum pedis*), narrow behind and broad in front, is situated in the middle of

* This aponeurosis has sometimes to be divided in the operation for the relief of club-foot.

the sole of the foot, between the plantar aponeurosis and deep muscles. It arises tendinous and fleshy from the middle of the lower surface of the heel-bone, internal annular ligament, deep surface of the plantar aponeurosis, and intermuscular septa, and passing forward, becomes somewhat spread out, and divides into four slips which soon terminate in as many delicate tendons. The tendons proceed forward, and diverging slightly, enter the fibrous sheaths upon the first and second phalanges of the toes, along with the tendons of the long flexor, and upon the under surface of the second phalanges each one splits for the passage of the long tendons into two slips, which uniting again around the tendon, are inserted together into the second phalanx.

Use.—To assist in flexing the toes.

The ABDUCTOR MUSCLE OF THE GREAT TOE (*abductor pollicis pedis*), long, narrow, and situated upon the under surface of the internal border of the foot, arises by two heads; one (the long head) from the internal surface of the tuberosity of the heel-bone and the plantar aponeurosis, and the other (the short head) from the external cuneiform and first metatarsal bones; it proceeds forward, and terminates in a flat tendon which is inserted into the internal side of the first phalanx of the great toe, and into a sesamoid bone in this situation.

Use.—To abduct the great toe (from the smaller toes).

The ABDUCTOR MUSCLE OF THE SMALL TOE, long, narrow, situated near the outer border of the foot, arises tendinous and fleshy from the outer side of the heel-bone, under surface of the fifth metatarsal bone, and plantar aponeurosis, proceeds forward, and is inserted by a short tendon into the base of the first phalanx of the small toe, upon its outer aspect.

Use.—To separate the small toe from the others.

Dissection.—The three preceding muscles form a superficial layer, covered below by the plantar fascia, and must be removed by detaching them from their posterior attachments, and reflecting them forward. By this means the tendons of the common long flexor of the toes, with its accessory muscle, and long flexor of the great toe will be brought into view. These having been examined, may also be turned forward, and the deep muscles will be brought into view.

The ACCESSORY MUSCLE (*musculus accessorius*), a flat square mass of fleshy fibres, arises from the inferior and lateral borders of the

heel-bone, proceeds forward, and is inserted into the outer border of the tendon of the common long flexor of the toes, just before its division.

Use.—To correct the obliquity of the tendon of the long flexor, and assist in flexing the toes.

The LUMBRICALES are four narrow, rounded, muscular slips, which arise from the angles between the tendons of the long flexor of the toes, proceed forward, and are inserted into the internal side of the first phalanges of the four smaller toes.

Use.—To adduct and assist in flexing the toes.

The SHORT FLEXOR MUSCLE OF THE GREAT TOE, situated along the outer border of the abductor, with which it is intimately connected, arises by a strong tendon from the heel-bone and external cuboid bone, proceeds forward, expands into a fleshy belly, and is inserted into the base of the first phalanx of the great toe by two short tendons, one on each side of the tendon of the long flexor. A sesamoid bone is found in each of the two tendons, where they pass over the head of the first metatarsal bone.

Use.—To assist the long flexor.

The ADDUCTOR OF THE GREAT TOE, situated upon the outer side of the short flexor, belongs properly to the interosseous group. It arises from the calcaneo-cuboid ligament, the sheath of the long peroneal tendon, and bases of the second and third metatarsal bones, proceeds forward, and is inserted in common with the outer tendon of the short flexor.

Use.—To draw the great toe toward the others.

The TRANSVERSE MUSCLE OF THE FOOT is a collection of fleshy fibres, that cross the under surface of the anterior extremities of the metatarsal bones, extending successively from the fifth to the first.

Use.—To approximate the heads of the metatarsal bones.

The PROPER FLEXOR MUSCLE OF THE SMALL TOE (*flexor brevis minimi digiti*) arises from the cuboid and fifth metatarsal bones, and is inserted into the base of the first phalanx of the small toe.

Dissection.—Remove the preceding muscles, and the tendon of the long peroneal muscle will be seen crossing the bottom of the foot, obliquely forward and inward, from the groove in the cuboid bone, to be inserted into the internal cuneiform and the base of the first metatarsal bone. The interosseous muscles will be also brought into view.

The INTEROSSEOUS MUSCLES, eight in number, including the adductor of the great toe, fill up the spaces between the metatarsal bones. They arise from the respective borders of the bones between which they are placed, and are inserted into the bases of the first phalanges of the toes. All the toes are provided with two (one on each side), except the great and the small toe, which have each a separate abductor placed along the corresponding borders of the foot.

USE.—They are all either adductors or abductors of the toes, taking the middle line of the foot as the point of departure.

The vessels and nerves of the leg and foot will be more particularly described hereafter, it being taken for granted that the student has reserved one limb for their special examination, and also for the study of the parts concerned in femoral hernia, to which he should now direct his attention.

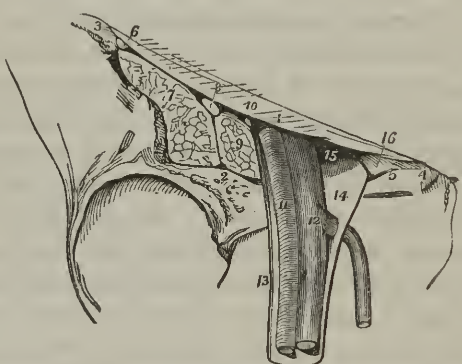
ANATOMY OF FEMORAL HERNIA.

The canal or passage through which femoral hernia occurs, extends from beneath the internal extremity of the crural arch (Poupart's ligament) to the opening in the femoral aponeurosis through which the saphenous vein communicates with the femoral; it is about an inch in length. The parts may be studied either from within or without; but if the pelvis has been divided, and a separate extremity reserved for this purpose and for the study of the vessels and nerves, it is best to commence within, and trace the canal to its external termination or outlet. Sponge the blood and other dirt from the soft parts situated upon the internal surface of the innominate bone, and from the adjacent surface of the anterior wall of the abdomen, and, if the peritoneum has been removed, it will be observed, in the first place, that the crural arch, which is nothing more than the lower edge of the tendon of the external oblique muscle, stretches from the superior anterior spine of the ilium to the spine of the pubis. In the latter situation it expands a little outward and backward, to form a small triangular prolongation, called Gimbernat's ligament, which occupies the angle between the internal extremity of the arch and the bone, is attached to the distance of half an inch or more along the ilio-pectineal ridge or line, and presents a free lunated border outward and a little backward. The large triangular space between the arch, the anterior margin

of the ilium, and the body of the pubis, is occupied by the psoas and iliac muscles, the crural nerve, and the external iliac artery and vein. The nerve is external to the psoas and upon the surface of the iliac muscle. The bloodvessels are upon the body of the pubis, internal to the two muscles between the psoas and the free edge of Gimbernat's ligament, and the vein upon the inner side of the artery. A closer examination will discover a quadrangular interval between the vein and the free margin of Gimbernat's ligament. It is bounded above by the crural arch, and below by the body of the pubis, and varies from half an inch to an inch in breadth either way, but generally it is larger in females than in males, on account of the somewhat greater breadth of the pelvis. This is the *entrance to the femoral canal* or the *internal femoral ring* (Fig. 134). It is occupied generally by a single lymphatic gland, and a small quantity of areolar tissue (called, by Cloquet, the *septum crurale*), and covered in by the parietal layer of the peritoneum. The disposition of the fasciæ of the abdomen, in reference to this opening, is a matter of some interest. Thus the transverse fascia (which lines the posterior surface of the transverse muscle in the inguinal region) and the iliac fascia (covering the surface of the psoas and iliac muscles, and continuous at the brim of the pelvis with the fascia lining this cavity) meet at the crural arch, and become attached to this structure in the outer two-thirds or three-fourths of its extent, thus strengthening the abdominal walls at this point. But internally to the psoas muscle, the external iliac artery and vein lie upon the surface of the iliac fascia, and pass out between it and the crural arch, so that this fascia, instead of being connected to the arch in this situation, is continued out behind or beneath the vessels, and over the body of the pubis. The transverse fascia passes out, in the same manner, in front or above the vessels beneath the arch (although connected to it), joining the preceding upon the posterior surface of Gimbernat's ligament. This continuation of the iliac fascia below, and the transverse fascia above, constitutes the sheath of the vessels, and, as the two membranes occupy in their descent the whole of the space between the inner border of the psoas muscle and the crescentic margin of the Gimbernat's ligament, the entrance or mouth of the sheath is large, embracing not only the bloodvessels, but the space between the vein and the ligament, which is the internal femoral ring. The femoral ring comprises, therefore, the internal half or third of the mouth of the sheath ; but as this structure descends it narrows, or, in other words, is funnel-shaped (infundibuliform), and

at the saphenous opening embraces the vessels closely, and is here continuous with the femoral aponeurosis. It will be understood, then, that the femoral canal is funnel-shaped; that it is nothing more than the unoccupied portion of the sheath of the femoral vessels lying internally to the vein; and that it extends from the internal femoral ring (by which it communicates with the cavity of the abdomen external to the peritoneum) to the saphenous opening in the femoral aponeurosis, the distance between the two being about an inch. The shape of the internal femoral ring is, as above stated, quadrangular, and its boundaries are the following unyielding structures: the crural arch *above*, the body of the pubis *below*, the femoral vein *externally*, and the crescentic margin of Gimbernat's ligament *internally*. But its relations must not be neglected. The epigastric artery is but a little way removed from its outer border; the obturator artery, generally a branch of the internal iliac artery, fre-

Fig. 183.



The femoral or crural arch, and the structures situated between it and the anterior part of the superior margin of the pelvis. 1. The crural arch, or Poupart's ligament. 2. Pubic bone. 3. Superior anterior spine of the ilium. 4. Spine of the pubis. 5. Pectineal line, and the insertion of Gimbernat's ligament. 7. Iliac muscle cut. 8. Crural nerve cut. 9. Great psoas muscle cut. 10. Point at which the crural branch of the genito-crural nerve reaches the thigh. 11. Femoral artery. 12. Femoral vein, receiving the saphenous vein. 13. External portion of the sheath of the femoral vessels lying in contact with the femoral artery. 14. The large funnel-shaped cavity of the sheath to the inner side of the femoral vein. 15. Internal femoral ring, bounded *above* by the crural arch, *behind* by the pubis, *externally* by the vein, and *internally* by the free edge of (16) Gimbernat's ligament.

quently arises from the femoral in common with the epigastric; in this case, in order to reach the obturator foramen, through which it almost invariably emerges from the pelvis, it either descends immediately along the outer boundary of the ring, or else travels along its superior boundary, and turns down behind the crescentic border of Gimbernat's ligament, thus encircling the upper half of the open-

ing. The latter disposition of this vessel is said, by most writers, to be rare, but, according to my observations, it occurs sufficiently often to make it a matter of serious consideration, in all cases where an operation is demanded. Thus, in something over a hundred and fifty dissections, the artery was found to originate from the epigastric once in nearly every four cases, the anomaly occurring with about equal frequency upon the two sides, and very often upon both. In the observed cases, the artery was found to pass along the superior and internal boundaries of the ring in about one out of every four or five, making a proportion of 1 to 16 or 18 out of the whole number of dissections.

The student should now make an examination of the saphenous opening or external femoral ring, which may be dissected in the following manner :—

Dissection.—Divide the skin by an incision extending from the superior anterior iliac spine vertically downward to the distance of eight or ten inches, and from its lower extremity extend another transversely inward to the inner border of the thigh; dissect up the flap, and turn it inward; next, raise the subcutaneous adipose tissue, which is often abundant, and the superficial fascia, in one layer, from the femoral aponeurosis in the same manner. When this is done, the femoral aponeurosis thus brought into view, will be seen to present just below the internal extremity of the crural arch, a considerable depression, occupied by areolar tissue, lymphatic glands, one or more small arteries (external pudics), and numerous veins, among which is the long or internal saphenous. Dissect out the areolar tissue and lymphatic glands close to the aponeurosis, commencing at the outer side of the depression, and cut off all the vessels except the large vein, and the external femoral ring will be brought into view, Fig. 184.

The *superficial fascia* covering this part of the thigh may be very easily split into two or more layers, but for all practical purposes it is best to consider it as one. It varies in thickness in different individuals, according to the degree of adipose development. It is intimately connected with the areolar tissue occupying the depression in the situation of the saphenous opening, rather loosely connected to the subjacent femoral aponeurosis upon either side, but more closely a short distance below this opening.* It forms one of the coverings of femoral hernia.

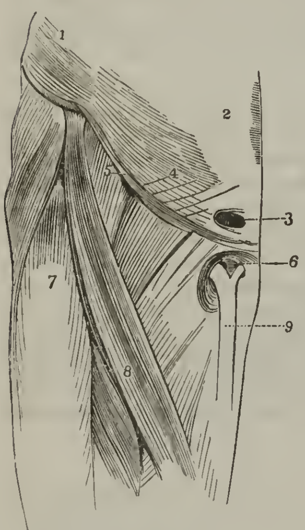
The areolar tissue filling the above-mentioned depression or excavation upon the surface of the femoral aponeurosis, is closely con-

* It is this close attachment of the superficial fascia to the femoral aponeurosis below the saphenous opening, that prevents the hernial tumor from descending lower upon the thigh, and causes it to turn up toward the crural arch, and spread out transversely.

nected to the superficial fascia and margins of the saphenous opening. It incloses three or four large lymphatic glands, and is traversed by one or two small arteries and the long saphenous vein, besides numerous smaller veins from the skin of the abdomen and scrotum. On account of being perforated by these several vessels, it is technically called the *cribriform fascia.*

The *internal* or *long saphenous vein* (Fig. 185) is the longest and largest superficial vein in the body; it commences by small twigs upon the inner side of the foot as far as the great toe, ascends along the inner side of the ankle and behind the internal condyle, increasing in size for the accommodation of the blood, which it receives by numerous branches from all the surrounding parts, continues its course almost vertically along the inner side of the thigh, resting upon the femoral aponeurosis, and about a half or three-quarters of an inch below the internal extremity of the crural arch, it perforates the aponeurosis, and terminates in the femoral vein.

Fig. 184.



Plan representing the upper part of the thigh with the skin and subcutaneous areolar tissue dissected off so as to show the femoral aponeurosis and its saphenous opening. 1. Fleshy portion of the external oblique muscle. 2. Tendinous portion of the same. 3. External abdominal ring. 4. Intercolumnar tendinous fibres. 5. Crural arch. 6. Saphenous opening through which (9) the saphenous vein reaches the femoral vein. 7. Thigh covered by the femoral aponeurosis. 8. Outline of the sartorial muscle, seen through the femoral aponeurosis.

The *saphenous opening* in the femoral aponeurosis, or the *external femoral ring* (Fig. 184), is situated in the upper anterior part of the thigh, about two inches from the pubic symphysis, and an inch below the anterior edge of the crural arch; it is oval in shape, occupied exclusively by the long saphenous vein, and remarkable for the peculiar arrangement of its margins. Its *lower edge* is sharp and lunated, crosses the front of the femoral vein, and embraces the under surfaces of saphenous vein, just as this vessel terminates in the femoral, or, rather, it occupies the acute angle formed by the two.* The *internal boundary*, situated upon a plane below the external, does not come to an abrupt edge, but sinks

* To get a good view of this margin, the saphenous vein should be divided two or three inches below, and turned upward.

behind the femoral vessels and sheath. It is connected to the posterior surface of the latter, and may be traced to the sheath of the femoral portion of the psoas muscle, and even to the capsular ligament of the hip-joint. The *external margin* is situated upon a plane, considerably above or anterior to the preceding. It extends from the outer extremity of the lower edge of the opening to the internal extremity of the crural arch, is curved with its concavity presenting downward and inward, crosses above and in front of the femoral vein, and also in front, the upper part of the internal boundary, and is continuous with the anterior division of the sheath of the femoral vessels. Owing to its arched form and its strong fibrous structure, it is commonly called the *falciform ligament.* It is the principal obstacle to the occurrence as well as to the reduction of hernia in this situation. In the ordinary extended position of the thigh, it is firm and tense, but may be relaxed by flexing and rotating the limb inward, and carrying it toward the opposite side.

Having completed the examination of the parts in their normal condition, the student may imitate the formation of femoral hernia by introducing his finger into the internal ring, and pushing it downward to the external. He will thus be enabled to form a very good idea of the relation of the several parts when hernia is actually present. In doing this, the lymphatic gland and areolar tissue (crural septum of Cloquet) occupying the canal will be first carried down; the finger (which, it must be borne in mind, is within the sheath of the femoral vessels) will then emerge from the sheath of the vessels at the saphenous opening, making its appearance first beneath the upper or transverse portion of the falciform ligament, its extremity covered by the above-mentioned areolar tissue, which has become spread out and compressed into a fascia. Having passed the saphenous opening, it is placed beneath the cribriform fascia, the superficial fascia, and the skin, and is crossed in front, between the internal and external rings, by the sheath of the femoral vessels, by the upper or transverse portion of the falciform ligament, and corresponding part of the crural arch, by the superficial fascia, and by the skin. In a case of hernia, the protruding intestine or omentum, besides being covered by the structures already mentioned, carries first before it the peritoneum, which covers the internal opening, and forms the true hernial sac. Again, the bowel may not pass the saphenous opening, but remain stationary in the canal, in which case it would be covered by the structures which lie across the front of the finger in the above-mentioned experiment. When, however, the hernia

does pass the external opening, as is more commonly the case, it turns upward over the transverse portion of the falciform ligament, and expands into a transversely oval tumor, covered by the same structures that invest the end of the finger; namely, 1, the skin; 2, the subcutaneous adipose tissue and superficial fascia; 3, the expanded cribriform fascia; 4, the expanded areolar tissue (crural septum), that occupies the canal; and lastly, the peritoneum or hernial sac. But it can be readily understood that the 2d, 3d, and 4th of these structures, being all of the same nature, will be blended with each other by the long-continued pressure exerted upon them in an old case, and that little regard is had by the surgeon to their distinction where an operation is called for. In fact, in cutting down upon the tumor, if the parts have become thickened by morbid deposits, as is very likely, in cases of long standing, the skin having been divided by a careful dissection, not less than half a dozen layers of fascia, or in other words, of condensed areolar tissue, may be raised before the hernial sac is reached, and it is mainly this circumstance that has given rise to so many discrepancies in regard to the number of coverings. There are properly but *two* coverings to the tumor besides the peritoneum or proper hernial sac, namely, the skin and a layer of condensed areolar tissue, formed by the blending of the superficial fascia, cribriform fascia, and crural septum of Cloquet, and susceptible of being split into quite a number of thin layers. But it is different at the narrow constricted part of the tumor formed by the femoral canal; here, the structures are unyielding and retain their integrity, and here it is that the stricture is seated; it may be at the internal ring, it may be at the saphenous opening, or it may be somewhere between the two.

An account of the operation for strangulated femoral hernia belongs more properly to works on surgery, but if the foregoing account of the relations of the different parts is as intelligible as it should be, and the student verifies it by a careful dissection, no great difficulty will lie in the way of his understanding what is to be done. Aside from the dangers attending the operation for strangulated hernia in general, the particular risk in cutting for femoral hernia consists in the very frequent anomalous position of the obturator artery and vein. As before mentioned, this artery is a branch of the epigastric, either upon one side or the other, about one time in four; and in about one out of every four or five of these cases, it winds along the upper and internal border of the internal ring before descending into the pelvis. In the latter case, it would

be almost impossible to avoid wounding it, if division of any of the structures forming the internal ring should become necessary.

VESSELS AND NERVES OF THE LOWER EXTREMITY.

The VEINS are superficial and deep-seated. The superficial veins are the internal or long, and the external or short saphenous. The ramify in the subcutaneous areolar tissue, upon the surface of the femoral and crural fasciæ, and may be exposed simply by removing the skin; but unless they have been previously filled by solid injection (which is rarely done in the dissecting room), it would not be advisable to attempt to trace out more than the main trunks.

The LONG OR INTERNAL SAPHENOUS VEIN (Fig. 185) commences upon the dorsal surface of the inner border of the foot, near the root of the great toe, runs backward toward the ankle, where it makes a turn in front of the internal malleolus, ascends along the inner side of the leg, behind the internal tuberosity of the tibia and corresponding condyle of the femur, continues upward upon the inner side of the thigh, and, having reached within about an inch of the crural arch, turns suddenly through the opening in the femoral aponeurosis at this point, and terminates in the femoral vein. In its course it receives a great number of collateral branches, and consequently increases gradually in size from below upward. It moreover receives communicating branches from the deep veins, and not unfrequently consists of two main trunks nearly parallel, communicating with each other by transverse branches, and uniting just at the saphenous opening. Near its termination in the femoral, the long saphenous vein receives the superficial epigastric, external pudic, and superficial circumflex iliac veins. The number of its valves varies from two to four or six, most of them below the knee. From the knee to the ankle the vein is accompanied by the long saphenous nerve, which leaves the femoral artery and vein, and perforates the fascia near the inner condyle of the femur.

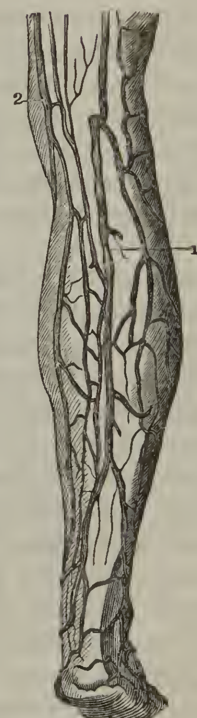
The EXTERNAL OR SHORT SAPHENOUS VEIN, situated upon the outer back part of the leg, commences on the dorsal surface of the outer border of the foot, passes behind the external malleolus, then turns directly upward, runs along the outer border of Achilles's tendon,

gains the middle of the calf of the leg, and ascends in this situation to the lower division of the popliteal space, where it perforates the

Fig. 185.

Long saphenous vein. 1. Superficial epigastric vein. 2. Internal pudic vein. 3. Superficial circumflex vein. 4. Origin of the long saphenous. 5. Its termination in the femoral vein.

Fig. 186.



1. External or short saphenous vein. 2. Internal or long saphenous.

fascia, and terminates in the popliteal vein. It receives a great number of collateral branches in its course, and before reaching its termination attains a considerable size. It has but two valves, one just at its termination, and the other some distance below, and hence, one reason for its great liability to become varicose. Between the ankle and the knee, it is superficial to the external saphenous nerve, being separated from it by the crural fascia.

The *deep veins* of the lower extremity accompany the arteries, and will be seen in the dissection of the latter.

The SUPERFICIAL NERVES, encountered in the removal of the skin from the lower extremity, are very numerous and small. They are nearly all derived originally from the lumbar sacral plexuses, and are either branches of the crural and sciatic nerves, or of the plexuses themselves. They perforate the femoral and crural aponeurosis at various points, descend to a greater or less distance in the subcutaneous areolar tissue, and are for the most part ultimately distributed to the skin. The only one of any particular practical importance is the *long saphenous*, which perforates the femoral aponeurosis beneath the inner condyle of the femur, and accompanies the long saphenous vein to the foot, and in division of this vein is liable to be wounded.

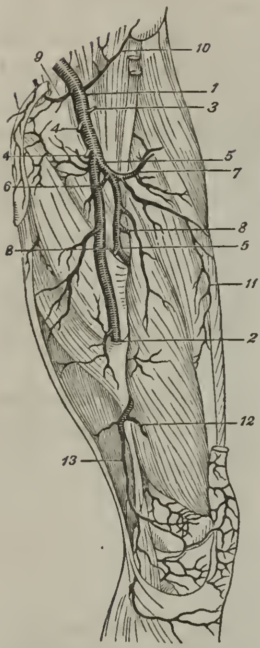
ARTERIES.—The special artery of the lower extremity is the femoral, but the upper back part of the thigh receives branches also from the divisions of the internal iliac, as heretofore seen.

THE FEMORAL ARTERY.

The femoral artery (Fig. 187), the continuation of the external iliac, descends almost vertically, inclining a little backward from beneath the middle of the crural arch, first upon the anterior, and then along the inner aspect of the thigh as far as its lower third, where it reaches the back of the limb, and is called the popliteal. It is considered, therefore, as consisting of two parts, one corresponding to the upper, and the other to the middle third of the thigh. The upper portion traverses in a vertical direction the middle of the femoral triangle, which is marked off, above, by the crural arch, externally, by the sartorial, and internally, by the long adductor muscle. It rests at first upon the psoas muscle, which separates it from the hip-joint, and then lies in front of the pectineus muscle. It is covered by the skin, superficial fascia, femoral aponeurosis, and common sheath which incloses the artery and vein. In the middle third of the thigh, the artery is situated deep upon the inner side of the femur, in the groove formed by the meeting of the long and great adductor muscles with the inner portion of the triceps, resting upon the tendons of the two former, and covered throughout by the sartorial muscle. In this situation it is, moreover, inclosed by a fibrous sheath

formed from the tendons of the muscles, between which it is placed. About the junction of the middle with the lower third of the thigh, the artery, accompanied by its vein, passes through the opening in the tendon of the great adductor muscle, to reach the lower back part of the femur, and becomes the popliteal.

Fig. 187.



Arteries of the thigh. 1 to 2. Femoral artery. 3 Superficial epigastric, cut off. 4, 4. External pudics, cut off. 5, 5. Deep femoral. 6. Internal circumflex. 7. External circumflex. 8, 8. Perforating arteries. 9. Epigastric. 10. Circumflex iliac. 11. Muscular branch. 12. Anastomotic branch. 13. One of its branches. The popliteal artery begins where the femoral terminates, at 2.

Femoral Vein.—The femoral artery is accompanied by one large vein, which, beneath the crural arch, lies upon the same plane with the artery, and upon the inner side of it, but traced from above downward, will be observed to get behind it, and gradually to incline to its inner side. The two are inclosed in the same sheath, and are joined about the middle of the femoral triangle by the long saphenous nerve—a branch of the crural—which descends along their inner border as far as the opening in the great adductor muscle, where it leaves them, passes forward, perforates the femoral aponeurosis, and joins the long saphenous vein.

Branches of the Femoral Artery.—The femoral artery gives off the external pudics, superficial epigastric, superficial circumflex iliac, deep femoral, and anastomotic arteries, besides several small twigs to the adjacent muscles, fascia, and skin. By far the most important of these is the deep femoral.

The *external pudic arteries*, very small, two in number, and called from their relative position the superior and inferior, arise from the inner side of the femoral artery, just below the pubis; they pass inward and upward, perforate the femoral aponeurosis, and are distributed to the skin of the lower part of the abdomen and external organs of generation.

The *superficial epigastric artery*, also very small, arises from the front of the femoral artery, about half an inch below the crural arch, passes through the saphenous opening in the femoral aponeurosis, and is distributed to the skin of the lower part of the anterior abdominal wall.

The *superficial circumflex iliac artery*, no larger than the preceding, near which it arises, passes outward, giving twigs to the subjacent muscles, per-

forates the aponeurosis near the superior anterior iliac spine, and is spent upon the integument.

The DEEP FEMORAL ARTERY (*profunda femoris*, Fig. 187) is nearly as large as the continuation of the main trunk from which it is derived. It arises from the outer back part of the common femoral, about an inch and a half below the crural arch, descends at first a little outward and then backward upon the iliac and pectineus muscles, passes behind the long adductor and rests upon the small and great adductors, and divides into three or four terminal branches which perforate the great adductor muscle, and are distributed to the muscles of the thigh.

The principal branches of the deep femoral are the external and internal circumflex, and perforating arteries. The *external circumflex*, quite large, arises from the outer aspect of the deep femoral, and sometimes from the common femoral, passes outward beneath the sartorial and middle head of the triceps muscle, the divisions of the crural nerve crossing behind and in front of it, and divides into a great number of branches which are distributed particularly to the muscles upon the outer side of the hip and thigh, anastomosing above with the branches of the gluteal and circumflex iliac arteries, and below with the articular branches of the femoral and popliteal. The *internal circumflex*, smaller than the preceding, arises from the inner side of the deep femoral, runs inward and backward beneath the pectineus muscle, and is distributed to the muscles in this situation. It sends a small branch (articular branch) through the notch of the acetabulum to the adipose tissue within the hip-joint and to the round ligament and head of the femur. The *perforating arteries*, three or four in number and quite large, are the terminal divisions of the deep femoral. They perforate the great and small adductor muscles near their insertion, and are distributed to the muscles upon the back of the thigh.

The deep femoral sometimes originates less than an inch and a half below the crural arch, a circumstance that adds to the difficulty and insecurity of placing a ligature upon the common femoral immediately below the arch. Very rarely it is given off more than two inches below.

The *anastomotic artery* is small, but constant in its occurrence. It arises from the femoral immediately above the opening in the great adductor muscles, descends towards the inner condyle of the femur in company with the long saphenous nerve, and is distributed to the parts about the knee-joint, anastomosing with the articular branches of the popliteal artery.

SURGICAL CONSIDERATIONS.—The femoral artery may be most conveniently compressed for the purpose of controlling its circulation either upon the body of the pubis or in the lower part of the femoral triangle. In the

former situation the vessel is almost superficial, and, lying directly upon the bone, is on these accounts very favorably situated for this purpose; but owing to the almost impossibility of adjusting a tourniquet to the limb so near the pelvis, or of conveniently grasping it with the hand when this is the compressing agent, this is not the point generally chosen, except in high amputations of the thigh, where either the tourniquet or the fingers, if applied lower down, would be in the way. In the lower part of the femoral triangle, although the artery is not so superficial or so near the bone, it is sufficiently so for the purpose, and, possessing the advantages just mentioned as wanting in the former situation, is altogether the most convenient point.

Ligature of the femoral artery may be practised in any part of its length, but where the vessel is nearest the surface, it is, of course, most accessible, and as a general rule the safest for the patient. Hence, the proper situation is the femoral triangle, for here the vessel is covered only by the integument, superficial fascia, and femoral aponeurosis. But all parts of the artery within the triangle are not equally favorable: thus, immediately below the crural arch it may be reached with but little difficulty, but a strong objection to applying a ligature here is the nearness of the origins of the epigastric and deep femoral arteries, it being a fact well ascertained that where a ligature is applied very near to a large collateral branch, and more especially between two, the danger of secondary hemorrhage arising from an imperfect obliteration of the vessel is much increased. The most advantageous point, therefore, is the lower angle of the femoral triangle, taking the inner margin of the sartorial muscle as the guide. Here no large collateral branch interferes, except in those very rare cases in which the deep femoral has a very low origin, and the vessel may be exposed without material difficulty.

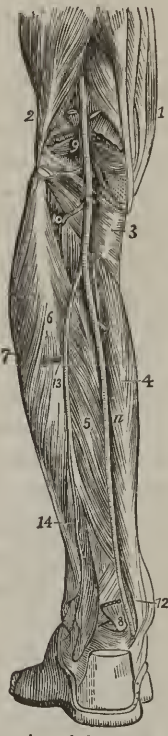
The POPLITEAL ARTERY (Fig. 188), the continuation of the femoral, descends, inclining a little outward, through the popliteal space, from where the femoral artery perforates the great adductor muscle, to the angle between the two heads of the gastrocnemius. In its course, it rests upon the posterior surface of the femur, the posterior ligament of the knee-joint, and the fascia covering the popliteus muscle; it is overlapped above by the semimembranous muscle, and covered in the rest of its course by the skin and an expansion of the femoral aponeurosis. Its relations to the popliteal vein and sciatic and peroneal nerves are important. The vein lies a little superficial to the artery and along its outer border, and the two are so intimately connected by close areolar tissue as often to render it difficult to separate them. The sciatic nerve is external to the vein, and more superficial; and the peroneal is still farther external, and separated by a considerable interval.

The popliteal artery sends small twigs to the hamstring muscles on each side, several considerable branches (sural arteries) to the heads of the gastrocnemius muscle, and five small branches to the knee-joint. Of the articular branches two are superior, two inferior, and one middle. The *superior articular* are given off behind the

condyles of the femur, encircle the lower extremity of this bone, and divide into numerous branches for the supply of the ligamentous and osseous structures about the joint. The *inferior articular* surround the head of the tibia and fibula, and likewise break up into a large number of small branches, which anastomose freely with the preceding, and supply the same structures about the lower part of the knee. The *middle* or *azygos articular* arises between the superior and inferior, enters the joint through the posterior ligament, and is distributed to the synovial membrane and adipose tissue within the cavity.

Having reached the lower border of the popliteus muscle, the popliteal artery divides into the anterior and posterior tibial arteries.

Fig. 188.



Posterior view of the left leg, showing the popliteal and posterior tibial arteries. 1. Tendons forming the inner hamstring. 2. Tendon of the biceps or outer hamstring. 3. Popliteal muscle. 4. Long flexor of the toes. 5. Posterior tibial muscle. 6. Fibula. 7. Long and short peroneal muscles. 8. Lower part of the long flexor of the great toe cut off. 9. Popliteal artery with its articular and muscular branches—the two superior articular, seen in the upper angle of the space passing above the cut heads of the gastrocnemius, the two inferior in relation with the popliteal muscle. 10. Origin of the anterior tibial artery. 11. Posterior tibial artery. 13. Peroneal artery, dividing a little below the number into two branches. 14. Posterior peroneal artery.

The POSTERIOR TIBIAL ARTERY (Fig. 188), the proper continuation of the femoral and popliteal, descends between the superficial and the deep layer of muscles on the back of the leg, and passes through the space between the internal malleolar process of the ankle and the heel, to reach the sole of the foot, where it divides into the internal and external plantar arteries. It is placed, at first, in the middle line of the leg covered by the deep fascia and the gastrocnemius and soleus muscles, but gradually inclines inward as it descends, and at the ankle lies behind the internal malleolus, between the tendons of the long flexor of the toes and long flexor of the great toe, covered by only the skin and internal annular ligament. It is accompanied by two veins, one on each side, and by the posterior tibial nerve, which is at first upon the inner side of the vessel, but soon

crosses to the outer side and maintains this position in the rest of its course.

With the exception of one considerable branch, the peroneal, the posterior tibial sends off only small twigs to the adjacent muscles and tibia.

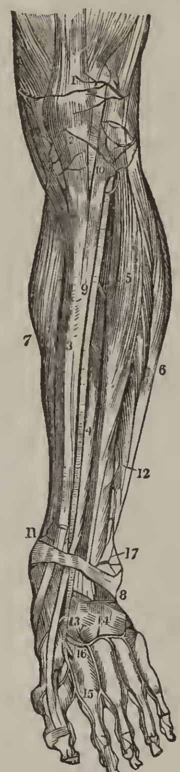
The PERONEAL ARTERY arises from the posterior tibial just below the margin of the popliteus muscle, passes at first downward and outward to reach the fibula, close beneath the inner border of which it descends, lying upon the interosseous membrane, to the outer side of the heel-bone, where it divides into a number of small branches. In its course, it gives off numerous twigs to the muscles and bone, and, about two inches above the external malleolus, sends off a branch called the *anterior peroneal*, which perforates the interosseous membrane, and descends upon the front of the fibula to the outer side of the ankle and foot.

The INTERNAL and EXTERNAL PLANTAR ARTERIES are the terminal divisions of the posterior tibial artery, this vessel bifurcating upon the inner back part of the sole of the foot, beneath the commencement of the abductor muscle of the great toe. The *external*, much the larger of the two, passes outward and forward between the short flexor of the toes, and the accessory muscle, to reach the fifth metatarsal bone, upon the tarsal extremity of which it turns toward the inner border of the foot; it traverses the under surface of the fourth, third, and second metatarsal, and joins the dorsal artery of the foot in the space between the first and second of these bones, forming thus an arch (plantar arch), from which branches are given to the several adjacent muscles, and to the four smaller toes. The *internal*, much smaller, passes forward near the inner border of the foot, supplies twigs to the abductor and short flexor muscles of the great toe, and finally expends itself upon the inner side of this toe.

The ANTERIOR TIBIAL ARTERY (Fig. 189), the anterior of the two terminal branches of the popliteal, passes at first forward between the heads of the posterior tibial muscle, and then through the interval in the upper extremity of the space between the tibia and fibula, where the interosseous membrane is deficient, to reach the anterior surface of the leg. It then descends upon the anterior surface of the interosseous membrane to the ankle, lying at first between the anterior tibial muscle and the long extensor of the toes, and lower

down between the former of these two muscles and the extensor of the great toe. In the upper part of the leg it is deeply seated, but becomes gradually more superficial as it descends, and just above the ankle it gets upon the anterior surface of the tibia, passes beneath the anterior annular ligament, and is crossed from without inward by the tendon of the extensor of the great toe. It is accompanied by two veins, one on each side, and also by the anterior tibial nerve, which, having crossed the head of the fibula, enters the interosseous space to the outer side of the vessels, but gradually gets in front of them as it descends.

Fig. 189.



Anterior tibial artery. 1. Tendon of the rectus muscle. 2. Patella ligament. 3. Tibia. 4. Extensor of the great toe. 5. Long extensor of the toes. 6. Long and short peroneal muscles. 7. Inner border of gastroenemius and soleus muscles. 8. Anterior annular ligament. 9. Anterior tibial artery. 10. Recurrent articular branch. 11. Internal malleolar branch. 12. Anterior peroneal artery. 13. Dorsal artery of the foot. 14. Tarsal and metatarsal branches. 15. Branch to the great toe. 16. Terminal branch to join the plantar arch. 17. External malleolar artery.

The branches of the anterior tibial artery are numerous and small, and distributed principally to the adjacent muscles. It sends off, also, just below the head of the tibia, a small *recurrent artery* which ascends through the head of the anterior tibial muscle, to the front of the knee-joint; and near the ankle an *internal* and an *external malleolar branch*, which are distributed to the corresponding surfaces of the joint.

The DORSAL ARTERY OF THE FOOT, the continuation of the anterior tibial, runs forward over the tarsal bones along the outer border of the tendon of the extensor muscle of the great toe, and having reached the space between the first and second metatarsal bones, passes through to join the plantar arch. Near its termination, it sends a small branch to the muscles occupying the first interosseous space.

NERVES OF THE LOWER EXTREMITY.

The principal nerves of the lower extremity, besides those already mentioned, in connection with the

muscles upon the back of the pelvis, are the crural, obturator, and great sciatic.

The CRURAL NERVE, the external terminal branch of the lumbar plexus, leaves the abdominal cavity beneath the crural arch, externally to the psoas, and upon the surface of the iliac muscle; having passed the arch, it turns a little outward, becomes somewhat flattened, and almost immediately divides into a lash of diverging branches, which are distributed principally to the rectus and triceps muscles upon the front of the thigh. One branch, called the *internal* or *long saphenous* nerve, gains the outer side of the femoral vessels which it accompanies, being inclosed in the same fibrous sheath, as far as the opening in the great adductor muscle; here it leaves the vessels, passes over the back of the internal condyle of the femur beneath the tendon of the sartorial muscle, and perforates the fascia to reach the long saphenous vein, which it accompanies to the foot. In its course, the long saphenous nerve gives off numerous filaments, most of which are distributed to the skin of the inner surface of the thigh, knee, leg, and foot.

The OBTURATOR NERVE, the smallest of the three terminal branches of the lumbar plexus, leaves the pelvis with the obturator artery, at the anterior superior angle of the obturator or thyroid foramen, and having reached the thigh, is distributed exclusively to the external obturator, gracilis, and three adductor muscles.

The GREAT SCIATIC NERVE (Fig. 190), the continuation of the sacral plexus, and by far the largest nerve in the body, leaves the cavity of the pelvis at the great sciatic foramen below the pyriform muscle, descends vertically at first between the great trochanter and ischiatic tuber, and then through the areolar interval between the hamstring muscles, and, having reached the superior angle of the popliteal space, divides into the internal popliteal sciatic or tibial, and the external popliteal sciatic or peroneal nerve. This division frequently takes place much higher up, and sometimes at the sciatic foramen.

At its exit from the pelvis, the great sciatic nerve is broad and flattened, but soon becomes rounded. It is covered at first by the great gluteal muscle, and lower down by the long head of the biceps, and rests successively upon the superior twin muscle, the tendon of the internal obturator, the inferior twin square, and great adductor

muscles. It sends off filaments to the biceps, semitendinous, semimembranous, and great adductor muscles, and one to the knee-joint.

The INTERNAL POPLITEAL SCIATIC* or TIBIAL NERVE (Fig. 190, 8, 9), the proper continuation of the great sciatic, descends vertically through the popliteal space, superficially and a little external to the popliteal vessels, and having passed between the heads of and beneath the gastrocnemius and soleus muscles, takes the name of the *posterior tibial nerve* (9); under this name it is continued down the leg with the posterior tibial vessels, which it accompanies to the sole of the foot, where it divides into the *external* and *internal* plantar nerves, and is finally distributed to the muscles of the sole and to the skin of the five toes. In its course it gives off a great number of branches to the knee-joint, and to the muscles and skin of the leg and foot. One of the principal of these branches, is the *external saphenous nerve* (communicans tibiæ), which arises in the lower part of the popliteal space, passes down the middle line of the posterior surface of the gastrocnemius muscle, perforates the fascia to gain the side of the short saphenous vein, runs along the outer margin of Achilles's tendon, turns around the external malleolus, and is distributed to the skin upon the outer border of the heel and foot. Some of its filaments reach as far as the small toe.

Fig. 190.

Great and small sciatic nerves. 1. Superior gluteal nerve. 2. Pudic nerves. 3. Small sciatic nerve. 5. Inferior pudendal branch. 6. Continuation of the small sciatic. 7. Great sciatic nerve. 8, 9. Internal popliteal sciatic or posterior tibial nerve. 10, 12. Short saphenous nerve. 11. Peroneal communicating branch. 13. External popliteal sciatic or peroneal nerve.

* Cruveilhier.

The EXTERNAL POPLITEAL SCIATIC or PERONEAL NERVE (13), the external division of the great sciatic, passes downward and outward through the popliteal space behind the external condyle of the femur, crosses obliquely over the external head of the gastrocnemius muscle and head of the fibula beneath the origin of the long peroneal muscle, turns horizontally forward, and divides into its two terminal branches. The *external peroneal*, or *musculo cutaneous branch*, passes downward through the muscles upon the fibula, to which it gives filaments, perforates the fascia a short distance above the ankle, follows the direction of the long extensor muscle of the toes, and is distributed to the skin upon the upper surface of the foot and roots of the toes. The *anterior tibial nerve*, the larger of the two, passes beneath the origin of the long extensor muscle of the toes to reach the outer side of the anterior tibial artery, which it accompanies to the dorsal surface of the foot, and is there distributed to the skin near the inner border of the foot as far forward as the great toe.

The peroneal nerve, while in the popliteal space, sends off the *peroneal, or short saphenous nerve.* This descends upon the posterior surface of the gastrocnemius muscle, and perforates the fascia about the middle of the leg to join the short saphenous vein which it accompanies along the outer border of Achilles's tendon, and is distributed to the skin upon the outer surface of the heel.

LYMPHATICS.—The *lymphatic glands* of the lower extremity are, 1, the *anterior tibial*, a single gland (often wanting), situated in the upper part of the space between the tibia and fibula, upon the anterior surface of the interosseous membrane ; 2, the *popliteal*, four in number, situated in the popliteal space, one of them superficial, and the others along the course of the popliteal vessels; and 3, the *inguinal*, superficial and deep. The *superficial* inguinal glands are situated in the depression upon the femoral aponeurosis, around the saphenous opening; they vary from three or four to as many as eight or ten in number, and differ very materially in size in different individuals. The *deep* glands are often wanting, but when present, they are found around the femoral vessels between the saphenous opening and the cavity of the pelvis. Their number is not constant, but rarely exceeds three or four; one is generally found occupying the internal femoral ring.

The *lymphatic vessels* of the lower extremity are superficial and deep. The *superficial* lymphatics are situated between the skin and femoral aponeurosis, and are arranged into two sets, the one accom-

panying the short saphenous vein to terminate in the popliteal glands, and the other the long saphenous vein to the inguinal group. The *deep* lymphatics accompany the large bloodvessels; a few upon the anterior part of the leg pass through the anterior tibial gland, the others enter the popliteal and inguinal groups, and all eventually form a chain of lymphatics along the external iliac artery, terminating in the lumbar glands. To reach this chain, the efferent vessels from the superficial inguinal glands perforate the femoral aponeurosis over the femoral canal, and pass beneath the crural arch.

The inguinal glands also receive the lymphatic vessels of the external organs of generation, perineum, lower part of the abdominal walls, and integuments of the outer side of the pelvis.

THE HEAD AND NECK.

The head consists of the cranium and face, the former containing the brain and its appendages, and the latter the organs of the senses and other important structures.

The superior part or top of the cranium should be dissected first. Upon each side of the median line, and immediately beneath the skin, there is a thin membranous muscle called the occipito-frontal, extending, as its name signifies, from the occiput to the forehead.

Dissection.—Divide the skin by a horizontal incision leading from the middle of the forehead to the occipital protuberance, and connect its two extremities by carrying the knife in the middle line over the top of the head. Commencing in front, remove the included flap of skin together with the subcutaneous areolar tissue. Much care is required in making this dissection to avoid cutting up the broad tendon or aponeurosis of the muscle along with the skin. Dissect the opposite side in the same manner.

The occipito-frontal muscle consists of an anterior and a posterior thin, pale, fleshy belly, and an intervening aponeurosis, which covers the top of the cranium. The *posterior* belly is attached by tendinous and fleshy fibres to the external two-thirds of the superior curved ridge of the occiput, and to the posterior part of the mastoid process, from which points the fibres ascend forward and inward to the distance of an inch or more, and end in the broad aponeurotic tendon. The *anterior* belly, somewhat thicker but paler than the posterior, descends from the anterior edge of the tendon, to be inserted, for the most part, into the integument of the eyebrow. A small fleshy slip is continued down from its internal part over the side of the nose, under the name of the pyramidal nasal muscle.

The occipito-frontal muscle is separated from the cranium by loose areolar tissue, and from the superjacent skin by a condensed layer of areolar adipose tissue. Its external margin slightly overlaps the temporal aponeurosis that covers in the temporal muscle; the internal is connected to the opposite muscle by a thin tendinous expan-

sion. Its anterior extremity is blended with the orbicular muscle of the eye.

Use.—To fix the skin of the head, elevate the eyebrows, and assist in raising the upper eyelid.

Removal of the Brain.—Having dissected off the occipito-frontal muscle, saw the skull upon a level with the tops of the ears, commencing the incision in front about an inch above the superior margins of the orbits, and terminating it behind, half an inch above the occipital protuberance. In doing this, it will become necessary to cut through the upper part of the temporal aponeurosis and muscle on each side. After the bones have been sawn completely through at all points, pry off the calvarium* by means of a chisel. This being done, the external surface of the dura mater, studded with vascular points and minute fibrous processes by which it is attached to the inner surface of the bones, will be exposed to view; but as this membrane cannot be entirely examined until the brain is removed, it should be divided upon a level with the sawn edge of the skull for two-thirds of the distance around, leaving an uncut portion in the middle line behind. In the median line in front, the scissors should be introduced to the depth of half an inch or more between the hemispheres of the brain, to divide the anterior extremity of the falciform process. The dura mater having been divided and turned back, the convoluted surface of the two cerebral hemispheres, separated from each other by an antero-posterior fissure, and covered by the pia mater and arachnoid membranes, will be brought into view.

The next step in the dissection is to remove the brain with the origins of the nerves, leaving the dura mater in the skull. For this purpose, gently elevate the anterior extremities of the hemispheres, and the two large bulbous nerves, constituting the first or olfactory pair, will be perceived lying upon the cribriform plate of the ethmoid bone, separated from each other by the crest; they may be detached from their situation by passing the handle of the scalpel underneath them. Raise the brain a little higher, and the two optic nerves, recognized by their large size and clear white color, may be seen leaving the cranium through the optic foramina in the sphenoid bone; divide them close to the bone, and also the two internal carotid arteries that lie immediately behind. Between the latter, and occupying the pituitary fossa of the sphenoid bone, is a transversely oval body called the pituitary body; it is attached to the base of the brain by a delicate pedicle called the infundibuliform process, and must be raised with the handle of the scalpel. Behind the optic nerves is the third pair, which leave the cranium through the sphenoidal fissure. These can be more conveniently divided with the scissors. Next, elevate the brain gently on each side, and, passing the edge of the scalpel along the superior border of the petrous portion of the temporal bone, divide the tentorium or transverse process of the dura mater, which stretches forward from the transverse ridge upon the occipital bone, for the purpose of supporting the posterior lobes of the cerebrum. Immediately beneath the anterior margin of this process is the fourth nerve or patheticus (often somewhat difficult to distinguish on account of its exceedingly small size), also on its way to the sphenoidal fissure. Directly behind the fourth, the fifth pair, the largest of the cerebral nerves, may be perceived passing forward to form a large ganglion (ganglion of Gasser),

* Calvarium, superior section of the skull.

which rests upon the inner extremity of the petrous bone. The main trunk of the fifth having been divided, taking care not to tear the nerve from its origin, the sixth pair will be discovered some little distance behind and nearer the median line, diverging slightly from each other toward the sphenoidal fissure. Continuing to elevate the brain, the seventh and eighth will be seen entering together the internal auditory foramen, close to which they should be divided. The ninth, tenth, and eleventh, composing what was formerly called the eighth pair, converge behind toward the jugular foramen, and should next be severed. Finally, the twelfth, the last of the cranial nerves, will be found immediately in front of the preceding entering the posterior condyloid foramen. These last having been divided, the blade of the knife should be carried some distance down into the spinal canal, and the cord divided, together with the two vertebral arteries, which enter the skull at the occipito-spinal foramen resting upon the basilar process of the occipital bone. The brain may be now entirely removed, leaving behind the dura mater and its lining of arachnoid; and, if it is not convenient to study it immediately, it may be placed in a jar of alcohol, or what is just as good, a weak solution of chloride of zinc.

MEMBRANES OF THE BRAIN.

The cerebro-spinal axis, comprising the brain and spinal cord, is invested by three separate membranes, namely, the dura mater, the arachnoid, and the pia mater.

The DURA MATER is a dense, strong, fibrous structure, which serves not only as a protection to the parts within, but as a periosteum to the internal surface of the cranial bones. It consists of two layers, by the separation of which, at different points, venous canals are formed and prolongations or processes that separate the cerebral hemispheres from each other and from the cerebellum. The membrane is not limited, however, to the cranial cavity, but descends into the spinal canal to invest the cord also; but only its cranial portion will now claim attention.

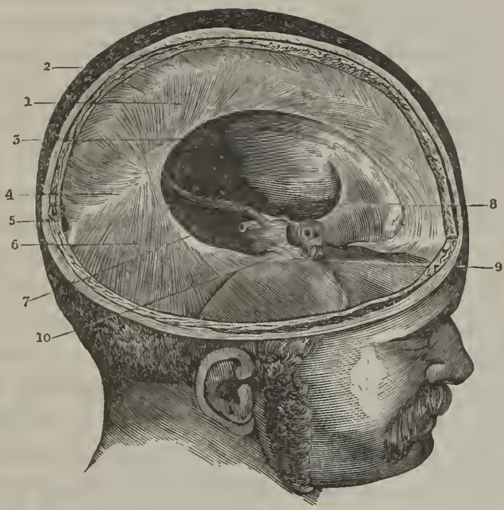
The *external surface* of the dura mater is rough, and adherent to the internal surface of the cranium by small fibrous processes and minute bloodvessels. This attachment, however, is not equally close at all points; it is greatest around the foramina through which the nerves have egress, and along the middle line of the vertex or top of the skull; but from the orbital plates of the frontal bone, the occipital fossæ and the squamous portion of the temporal bone, it may be torn off without difficulty. The degree of adhesion varies also at different periods of life, being much greater in old persons and children than in the middle-aged. Upon this surface the ramifications

of the meningeal arteries may be perceived. The most important of them, the *middle meningeal*, spreads out in an arborescent manner, over that portion of the membrane which corresponds to the parietal bone. The *internal surface* is lined by the external or parietal layer of the arachnoid, which is so intimately attached, as to justify the name of fibro-serous membrane, applied to the dura mater.

The processes or internal prolongations of the dura mater are the falx of the cerebrum, the tentorium, and the falx of the cerebellum.

The *falx* or *falciform process of the cerebrum* (Fig. 191), so called from its scythe-like shape, is situated along the middle line of the cranium, extending from the crest of the ethmoid bone in front to the middle of the tentorium behind. It is broad behind, and narrow in front, and has a superior convex and an inferior concave border;

Fig. 191.



Oblique view of the interior of the cranium lined by the dura mater. 1. Falciform process. 2. Its attached border containing the longitudinal sinus. 3. Its free border. 4. Continuation of the falciform process with (6) the tentorium. 7, 8. Free concave edge of the tentorium. 9. Termination of this edge at the anterior clinoid process. 10. Attached border of the tentorium continued along the upper angle of the petrous bone to the posterior clinoid process.

the former is occupied by the superior longitudinal sinus, and attached to the middle line of the vault of the cranium; the latter is a thin and free edge, inclosing a small vein called the inferior longitudinal sinus. This process is formed by a doubling of the internal lamina of the dura mater upon itself; it is covered by the parietal portion of

the arachnoid, and in relation by its two surfaces with the inner faces of the cerebral hemispheres. In the natural position, it is very tense, and serves to prevent the hemispheres from impinging upon each other, when the head is jarred or shaken by external violence.

The *tentorium* is horizontal in its direction, and, like the falx, is formed by a reduplication of the internal layer of the dura mater, covered upon each side by the external layer of the arachnoid. It is attached along the transverse arms of the crucial ridge of the occipital bone, to the superior angles of the petrous bones, and to the clinoid processes of the sphenoid. It is deeply notched in front, so as to form with the basilar process of the occipital bone, an oval-shaped opening for the transmission of the peduncles of the cerebrum. Its superior surface is convex, and receives the weight of the posterior lobes of the cerebral hemispheres; its inferior is concave, and corresponds to the convexity of the cerebellum.

The *falx of the cerebellum* is a small vertical fold, passing up from the posterior margin of the large foramen of the occipital bone to the under surface of the tentorium; it is attached to the lower vertical portion of the crucial ridge, and serves to separate the hemispheres of the cerebellum.

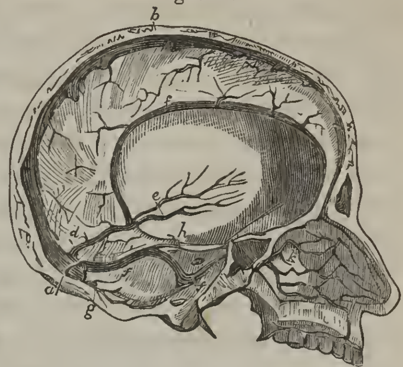
VESSELS.—The dura mater, like all other fibrous structures, receives but little arterial blood; the meningeal arteries ramifying upon its surface, belong rather to the cranial bones than to the membrane. Its veins, independent of the sinuses, are two with each meningeal artery.

NERVES have not been satisfactorily demonstrated in it, although most authors admit the presence of branches from the fifth pair.

In connection with the dura mater, it is proper to mention the Pacchionian Bodies. These are small, whitish, granular-looking bodies, found generally in clusters along the attached border of the falciform process. They do not exist in young children, but in old persons they are very numerous, and by their pressure often form deep depressions in the parietal bones on each side of the sagittal suture. Although generally situated upon the outer side of the membrane, they are sometimes found between its two layers, or even in the longitudinal sinus; they also sometimes exist in great numbers in the lateral ventricles of the brain. Their organization is not glandular, although they are usually called the glands of Pacchioni; their function is wholly unknown.

SINUSES OF THE DURA MATER.—These are venous canals, situated between the two layers of the membrane, and lined by a continuation of the internal coats of the veins. They are fourteen in number, and all communicate with each other, and ultimately terminate at the jugular foramen, where they become continuous with the internal jugular vein. Ten of the number exist in pairs, and are, on each side, the cavernous, superior and inferior petrosal, occipital, and lateral. The single, four in number, are situated in the median line; they are the superior longitudinal, straight, transverse or basilar, and coronary. What is called the inferior longitudinal sinus, is properly a vein.

Fig. 192.



Sinuses of the dura mater. *b*. Superior longitudinal sinus. *c*. Inferior longitudiual sinus. *d*. Straight sinus. *f*. Left lateral sinus. *g*. Occipital sinus. *h*. Superior petrosal sinus. *i*. Inferior petrosal sinus. *a*. Junction between the superior longitudinal, straight, and occipital sinuses, called the toreular or press of Herophilus, from which the two lateral sinuses originate *e*. Veins of Galen, which unite with the inferior longitudinal to form the straight sinus.

The *superior longitudinal sinus* (Fig. 192, *b*), is inclosed within the attached border of the falciform process, and extends from the blind foramen in front of the ethmoidal crest to the occipital protuberance, where it bifurcates to form the two lateral sinuses. In order to be seen, it should be divided transversely, and then slit open. It commences very small in front, but rapidly increases in size, and if examined just above its termination, will be found nearly large enough to admit the end of the little finger. It is triangular in shape, with one angle pointing vertically downward, and, when laid open, presents a reticulated appearance, produced by small fibrous cords, that pass between the contiguous sides for the purpose of increasing its strength. It receives the superior cerebral veins, most of which open obliquely from behind forward, by a kind of valvular perforation; also the veins of the diplöic structure of the cranial bones, and of the dura mater itself.

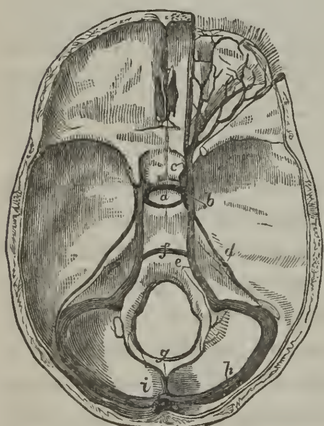
The *straight sinus* (*sinus rectus*) (Fig. 192, *d*) is situated between the base or posterior extremity of the falx and the superior surface of the tentorium, being formed by the separation of the two layers of the former, to become continuous with the superior layer of the latter. It is quite large, triangularly prismatic in shape. It com-

municates behind with the superior longitudinal sinus, just at its bifurcation, and receives in front the veins of Galen, hereafter to be mentioned, and the small vein called the inferior longitudinal sinus (*e*), which runs along the free border of the falx.

The two *lateral sinuses* (Fig. 192, *f*, and 193, *h*) commence opposite the internal occipital protuberance, at the bifurcation of the superior longitudinal, and the termination of the straight sinus, and pass horizontally outward along the crucial ridge, being situated here in the attached border of the tentorium; they soon leave this, however, and, crossing the posterior inferior angle of the parietal bone on each side, enter the furrow upon the mastoid portion of the temporal bone, and terminate in the internal jugular veins at the jugular foramina. The right is usually the larger of the two.

The occipital sinuses (Fig. 193, *g*), two in number, and very small, are situated along the attached border of the falx of the cerebellum; they commence on each side of the spinal opening of the occipital bone, and frequently uniting to form a single trunk, they ascend and open into the bifurcation of the superior longitudinal sinus.

Fig. 193.



a. Circular sinus. *b*. Cavernous sinus. *c*. Ophthalmic veins. *d*. Superior petrous sinus. *e*. Inferior petrous sinus. *f*. Basilar sinus. *g*. Occipital sinus. *h*. Right lateral sinus. *i*. Press of Herophilus.

The point at which the superior longitudinal, straight, and occipital sinuses unite, is situated opposite the internal occipital protuberance, and was called by the older anatomists, the *press of Herophilus* (*torcular Herophili*), upon the supposition that the blood here underwent some degree of compression.

The *cavernous sinuses* (Fig. 193, *b*) are situated upon the sides of the body of the sphenoid bone. They are short but large, and are divided internally into several compartments by fibrous bands, and by the internal carotid arteries, and sixth pair of nerves which pass through them. Like the other sinuses they are contained between the two layers of the dura mater, and are lined by a continuation of the internal membrane of the veins. In front they receive the ophthalmic veins, and behind, give origin to the two petrosal sinuses on each side.

The *circular sinus* (Fig. 193, *a*), very small, surrounds the pituitary body on the pituitary fossa, and communicates on each side with the cavernous sinus.

The *superior petrosal sinus* (Fig. 192, *h;* 193, *d*), on each side, also very small, originates from the cavernous sinus, passes outward and backward along the superior angle of the petrous bone, and terminates in the lateral sinus upon the mastoid portion of the temporal bone.

The *inferior petrosal sinus* (Fig. 192, *i*, and 193, *e*), much larger than the preceding, commences in the cavernous sinus, passes along the line of contact between the petrous bone and basilar process of the occipital, and terminates in the lateral sinus, just at the jugular foramen.

The *basilar or transverse sinus* (Fig. 193, *f*) is a small short branch communicating between the two inferior petrosal upon the upper surface of the basilar process.

The ARACHNOID is a serous membrane, and therefore a close sac, consisting of a parietal and a visceral layer.

The parietal layer lines the internal surface of the dura mater and its prolongations, and is so closely adherent that it can be detached only in small strips or patches.

The visceral layer, also thin and transparent, invests the surface of the brain wherever this organ is in contact with the dura mater. It is connected to the subjacent pia mater by areolar tissue, which, upon the prominent parts of the convolutions, is short though not very close, but over the intervening sulci or furrows, and other depressions, is quite loose and open. This loose attachment also occurs upon the middle of the base of the brain, and where the membrane stretches from the spinal cord to the under back part of the cerebellum.

The contiguous surfaces of the arachnoid are smooth and glistening, and constantly bedewed by a serous exhalation, which, although so scanty in the healthy condition of the parts as to be barely perceptible, may, in chronic inflammation of the membrane, become so abundant as to require to be drawn off by an operation.* The continuity of the parietal and visceral layers may be seen at the base of the brain; here the visceral layer will be found to form tubular

* The fluid contained within the arachnoid sac, must not be confounded with that found in the subarachnoid areolar tissue.

sheaths for the nerves, up to the point where they leave the cavity of the cranium, whence it is reflected off to become continuous with the parietal layer.

The PIA MATER lies next the substance of the brain, and, like the dura mater and arachnoid, consists of a cranial and a spinal portion. The cranial portion is made up principally of the ramifications of the arteries of the brain, and of the radicles of its veins, held together by a small amount of fibro-areolar tissue. When finely injected, it may be traced as a continuous membrane over the whole extent of the cerebrum and cerebellum, upon the surface of and between the convolutions, and into the interior cavities of the organ.

The pia mater is the nutrient membrane of the brain, and belongs to the class of fibro-vascular membranes. The cranial portion is more distinctly vascular, the spinal portion more fibrous.

ARTERIES OF THE BRAIN.

DISSECTION.—To expose the arteries of the brain, remove the visceral layer of the arachnoid and the subarachnoid areolar tissue from the middle of the base of the brain, and trace out each vessel separately, taking care not to cut or lacerate the cerebral substance, nor to tear away the origins of the nerves.

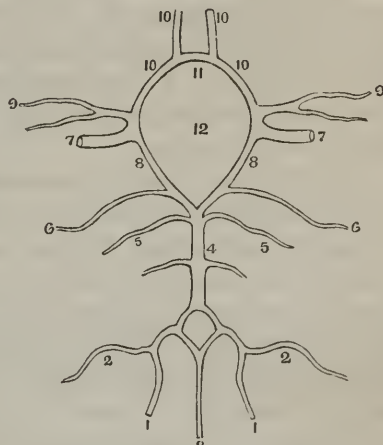
The arteries of the brain are four in number, and not remarkably large, considering the size and activity of the organ which they supply. They are the two vertebral and the two internal carotid arteries.

The *vertebral arteries* (Fig. 194, 1, 1) originate from the subclavian, deep in the lower part of the neck, and ascending through the foramina in the transverse processes of all the cervical vertebræ, excepting the seventh, they enter the cavity of the skull from opposite sides of the occipito-spinal foramen. From this point (where it is supposed they have been divided in removing the brain) they converge, and opposite the posterior margin of that large prominence on the under surface of the small brain, known as the Varolian bridge, they unite to form a single trunk, which, running forward to the distance of an inch or more, divides into four branches, two on each side. Before uniting, however, the vertebral arteries give off the following branches: 1. The *anterior spinal* (3), a small twig that originates by two roots, one from each of the main trunks, and descends in front of the spinal cord to its inferior extremity. 2. The *posterior spinal*, one on each side, and very small, winds around the upper

extremity of the cord, and descends upon its posterior surface without uniting with its fellow. 3. The *posterior meningeal*, a mere twig to the dura mater in the vicinity of the spinal opening of the occipital bone. 4. The *inferior cerebellar* (2, 4), a considerable branch originating from the vertebral just before it unites with its fellow to form the basilar, and often from the basilar itself, passes out in a tortuous manner to the under surface of the cerebellum to which it is distributed. It gives off a small twig, which enters the internal auditory meatus to be distributed to the internal ear.

The *basilar artery* (4), formed as above mentioned, is situated in the median line between the basilar process and the under surface of the Varolian bridge. It is about the size of a crow-quill; it gives off in its course several small branches,* and terminates in front of the bridge by dividing into the two superior cerebellar, and the two posterior cerebral arteries. The *superior cerebellar* (5, 5) pass from their origin immediately around to the superior parts of the cerebellum, upon which they become spread out. The *posterior cerebral* (6, 6) originate just in front of the preceding, from which they are separated by the third nerve ; they proceed forward for a little way to receive the posterior communicating arteries—a small branch from the internal carotid on each side—and then wind outward upon the under surface of the posterior lobes of the cerebrum.

Fig. 194.



Arteries of the brain. 1, 1. Vertebral arteries. 2, 2. Inferior cerebellar arteries. 3. Anterior spinal artery. 4. Basilar artery. 5, 5. Superior cerebellar arteries. 6, 6. Posterior cerebral arteries. 7. Internal carotid. 8, 8. Posterior communicating branches. 9, 9. Middle cerebral arteries. 10, 10. Anterior cerebral arteries. 11. Anterior communicating artery. 12. Circle of Willis.

The *internal carotid artery* (7, 7) of each side enters the cavity of the skull through the carotid canal in the petrous bone, and inclines forward, resting upon the side of the sella turcica, and inclosed by the cavernous sinus. Having reached the anterior clinoid process, it bends almost directly upward beneath, and upon the inner side of this

* The inferior cerebellar is often a branch of the basilar.

process, and divides upon the base of the brain into the following branches: 1. The *anterior cerebral* (10, 10), quite a large vessel, runs forward and inward to the anterior termination of the antero-posterior fissure that separates the two hemispheres of the brain; here it communicates with its fellow by a very short trunk, called the *anterior communicating artery* (11), and then entering the fissure, curves backward along the inner side of the corresponding hemisphere as far as its posterior lobe. 2. The *middle cerebral artery* (9, 9), also quite large, passes outward into the fissure of Sylvius that separates the anterior and middle lobes of the brain, and subdivides into branches for the supply of the middle parts of the hemisphere. 3. The *posterior communicating artery* (8, 8), very small, runs directly backward to join the posterior cerebral, a branch of the basilar.

It will be seen that, by the short transverse branch connecting the two anterior cerebrals, and by the two posterior communicating branches which extend between the internal carotid on each side, and the two posterior cerebrals, that a complete vascular circle is formed, commonly called the *circle of Willis*. The object of this free anastomosis is to allow all parts of the brain to be equally supplied with blood, when, from any cause whatever, the circulation may be impeded or arrested in any one of the main trunks. It is also owing to this free communication that the surgeon is enabled to tie one or even both the carotids in the neck, without material injury to the functions of the brain.

DISSECTION.—After completing the study of the membranes and vessels, the student may proceed to the dissection of the brain itself, or this may be deferred until a more convenient time, and the face or the neck commenced upon. If, however, there is no danger of the rest of the subject spoiling, the brain should be gone through with at once.

THE BRAIN.

Under the general term brain or encephalon, is ordinarily included all that part of the cerebro-spinal centre contained within the cavity of the skull. It consists of three divisions or parts, namely: the cerebrum or large brain, the cerebellum or small brain, and the oblong medulla. It is irregularly oval in shape, its long diameter directed antero-posteriorly, and its large extremity presenting backward. Its under surface, which is irregularly flattened, constitutes

what is called the *base* of the organ, and rests upon the floor of the cranium.

Fig. 195.

A plan in outline, showing, in a lateral view, the parts of the encephalon separated somewhat from each other. A. Cerebrum. *f*, *g*, *h*. Its anterior, middle, and posterior lobes. *e*. Fissure of Sylvius. B. Cerebellum. C. Varolian bridge. D. Oblong medulla. *a*. Peduncles of cerebrum. *b*. Superior. *c*. Middle; and *d*. Inferior peduncles of cerebellum. The parts marked *a b*, *c* C, form the isthmus encephali.

The size of the brain is subject to great variety, but its average weight, as deduced from the observations of a number of authors,* is 49½ oz. (avoirdupois) for the male, and 44 oz. for the female. The maximum weight is stated at 65 oz.,† and its minumum 34 oz. The weight does not seem to be always proportionate to the size of the cranial cavity‡ and in the human subject, at least, bears no fixed relation to the size of the body.

The weight of the human brain being taken at about 3 lbs. (48 oz.), it is found to be absolutely heavier than the brain of all the lower animals, except the elephant and whale. In the elephant, the brain, according to Perrault, Moulins, and Sir A. Cooper, weighs between 8 and 10 lbs.; whilst that of the whale was found by Rudolphi, in a specimen 75 feet long, to weigh upwards of 5 lbs.§

* Table in Sharpey and Quain's Anatomy.

† Cuvier's brain, the largest on record, weighed upwards of 64 oz., and that of the late Dr. Abercrombie 63 oz.—*Op. cit.*

‡ The brain of the late Daniel Webster weighed only 52 oz., whereas, the cranial cavity was next to the largest on record.

§ Tiedeman, quoted by Sharpey and Quain.

THE CEREBRUM.

The cerebrum occupies all that part of the cranial cavity situated above and in front of the tentorium, and is therefore by far the largest of the three divisions of the brain. It is somewhat oval in shape, with its large extremity presenting backward. It is irregularly flattened upon its under surface or base, and marked over the whole of its exterior by winding elevations called convolutions, which are separated by intervening depressions or sulci. A deep fissure (longitudinal fissure) extends throughout its whole length in the median line above, lodging the falciform process of the dura mater, and dividing the organ into two lateral halves, inappropriately called hemispheres." Each hemisphere is subdivided upon its basilar surface into three lobes, an anterior, a middle, and a posterior. The *anterior lobe* rests upon the roof or superior wall of the orbit of the eye, and is correspondingly concave upon its under surface. It is separated from the middle lobe by a depressed line called the fissure of Sylvius, which, commencing at the middle of the base of the organ, curves forward and outward, and then upward, and lodges the posterior edge of the lesser wing of the sphenoid bone and the projecting line of union between the greater wing of the same, and the external angular process of the frontal bone. The *middle lobe* is prominently convex, and occupies the middle fossa at the base of the skull. The *posterior lobe* is not defined from the preceding by any line or fissure, the two forming properly only one lobe, but it is considered as comprising so much of the organ as rests upon the tentorium, behind the upper edge of the petrous portion of the temporal bone.

Convolutions.—The three free surfaces of each hemisphere, namely, the base, the external convex, and the internal flat surface presenting toward the falx, are all marked by the convolutions and furrows (*sulci*) just mentioned. The number of these convolutions cannot be accurately stated on account of their continuity with each other, and the irregularity of their distribution in different individuals. Their size is also subject to great differences, both in different persons and at different periods of life, being usually greater in persons of an active mental constitution,* and also greater in middle life than in childhood or advanced age. The inter-

* Gall.

vening sulci, or anfractuosities, as they are sometimes called, are properly only involutions or a doubling in of the surface, and vary in their depth, as do the convolutions in their size and prominence.

The great number and size of the convolutions and involutions of the cerebrum, distinguish the brain of man from that of all other animals, and as the principal object of this configuration seems to be to increase the extent of the free surface of the organ, it is presumable that the superior mental endowment of man over all other animals, and of one individual over another, is due to the same circumstance, a supposition that is in some degree confirmed by the fact that, in idiots, the convolutions are found to be comparatively few, and of a remarkably small size.

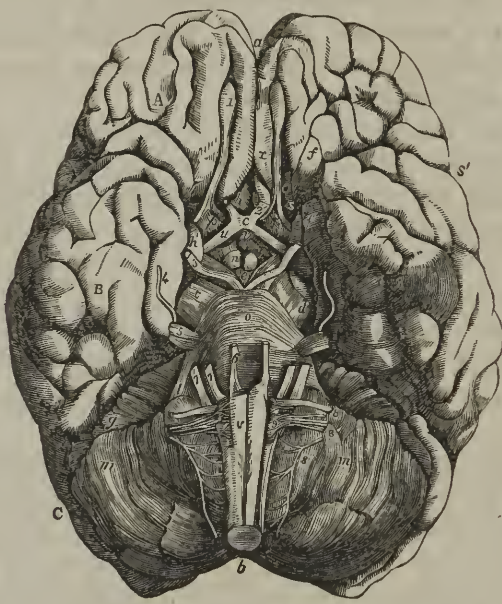
Base of the Cerebrum.—Before proceeding to the dissection of the interior of the cerebrum, the student is advised to make himself acquainted with the principal points of interest upon the base of the organ, excepting the origin of the nerves, the study of which should be deferred until the interior of the organ has been dissected. For this purpose the areolar tissue and bloodvessels in this situation should be carefully removed, leaving the nerves untouched.

The objects of study upon the base of the brain are either single or in pairs; the former are situated in the median line, and the latter on each side.

Commencing on the middle line in front, we find the anterior termination of the great *inter-hemispheric* or *longitudinal fissure* (Fig. 196 *a*), which here separates the two anterior lobes of the cerebrum, and lodges the crest of the ethmoid bone. Immediately behind this is the *optic commissure* or *chiasm* (*c*), formed by the crossing of the fibres of the optic nerves, and situated, when the brain is in the cranium, upon the olivary process of the sphenoid bone, just in front of the pituitary fossa. Directly posterior to the commissure is a slight grayish protuberance of a triangular shape, called the *gray tuber* (*tuber cinereum*) (*r*), to the centre of which is attached a small cylindrical prolongation called the *infundibuliform process;* the former constitutes the floor of the third ventricle, and is very thin and easily torn; the latter is only a prolongation of this cavity in the form of an exceedingly narrow canal without any external outlet. Connected to the inferior extremity of the process is the *pituitary body*, which, in the removal of the brain, is generally left in its situation in the pituitary fossa of the sphenoid bone; it is of a yellowish-gray color, irregularly oval in shape, and may be divided into an anterior and a posterior lobe. It is very vascular, and

although solid, is easily broken up when pressed between the fingers. Behind the gray tuber are two small light-colored bodies, about the size and shape of a split pea, called the *white bodies of Willis*, technically the *corpora albicantia* (*n*). These lie close to each other, but are separated by a narrow groove that leads backward to a triangular-shaped depression, named the *inter-peduncular* or *posterior perforated space* (*locus perforatus*) (*e*), so called from its

Fig. 196.



Base of the brain. A, anterior, B, middle, and C, posterior lobe of the cerebrum. *a.* Forepart of the longitudinal or inter-hemispheric fissure. *b.* Notch between the hemispheres of the cerebellum. *c.* Optic commissure. *d.* Left peduncle of the cerebrum. *e.* Posterior perforated space. *e* to *i.* Inter-peduncular space. *ff.* Convolution of the Sylvian fissure. *i.* Infundibulum. *l.* Right middle peduncle of the cerebellum. *m, m.* Hemispheres of the cerebellum. *n.* White bodies of Willis. *o.* Varolian bridge, forming by its continuation on each side the middle peduncle of the cerebellum. *p.* Anterior perforated space. *q.* Horizontal fissure of the cerebellum. *r.* Gray tuber. *s, s.* Sylvian fissure. *t.* Left peduncle of the cerebrum. *u, u.* Optic tracts. *v.* Oblong medulla. *x.* Marginal convolution of the longitudinal fissure. 1. Olfactory nerve. 2. Optic. 3. Common motor of the eye. 4. Trochlear or pathetic. 5. Trigeminal or trifacial. 6. Abducent. 7. Facial. 7. Auditory. 8. Glosso-pharyngeal. 8. Pneumogastric. 8. Spinal accessory. 9. Hypoglossal.

perforated or cribriform appearance, when the little vessels that enter the organ at this point are drawn out. Bounding the perforated space laterally are the *peduncles* or *legs of the cerebrum* (*crura cerebri*) (*d, t*), two large, white, fibrous-looking masses, that proceed in a diverging manner forward and upward, to enter the interior of the two hemispheres. They consist of medullary fibres on

their way from the anterior part of the spinal cord to the cerebrum, and they inclose a small mass of dark substance called the *locus niger*. Next, behind the perforated spot and the cerebral peduncles, is the large quadrangular convex body called the *annular protuberance* or *Varolian bridge* (*pons Varolii*) (*o*), which consists of the white fibres of the cerebellum, crossing beneath and in front of the continuation of the spinal cord that constitutes the peduncles. In front of the inferior surface of each peduncle, at the inner extremity of the fissure of Sylvius, and immediately external to the optic commissure, is a small triangular space perforated by numerous small vessels called the *anterior perforated space* (*substantia perforata*) (*p*), in contradistinction to the posterior, which is situated between the peduncles.

Dissection of the Cerebrum.—Turn the brain upon its base, press the two hemispheres gently asunder, and at the bottom of the fissure divide the arachnoid membrane where it stretches across, and the superior surface of the *great cerebral commissure*, or *corpus callosum*, will be brought into view. Next, introduce a scalpel into the fissure, and, with the blade placed flatwise, dissect off, by repeated strokes from within outward, one of the hemispheres on a level with the commissure. The gray and white substances of which the brain is composed may now be readily distinguished.*

The appearance presented upon a transverse section of one hemisphere on a level with the great commissure, is called the *small oval centre* (technically, the *centrum ovale minus*), consisting of an oval plane surface of white medullary substance, bordered by a zigzag line of gray, except along the continuity of the commissure.

The *gray substance*, constituting the cortical or superficial portion of the cerebrum, is spread out over nearly the whole of the exterior in the form of a continuous layer, varying from one to two or three lines in thickness, and so folded upon itself as greatly to exceed the superficial surface of the organ. This folded arrangement forming the convolutions and involutions, is well seen upon this cross section, and from it some idea may be had of the large extent that the layer would cover, if it were dissected off entire, and spread out upon a plane surface. The depth to which the involutions reach may be also here noticed; some of them measure an inch or more from the surface, and others not more than two or three lines.

The *white* or *medullary substance* is inclosed by the cortical layer, and constitutes by far the larger part of the organ. In its fresh state it is soft but tenacious, of a clear yellowish-white color, and apparently of a homogeneous nature throughout. When hardened by

* For an account of the structure of the nervous centres, see page 59.

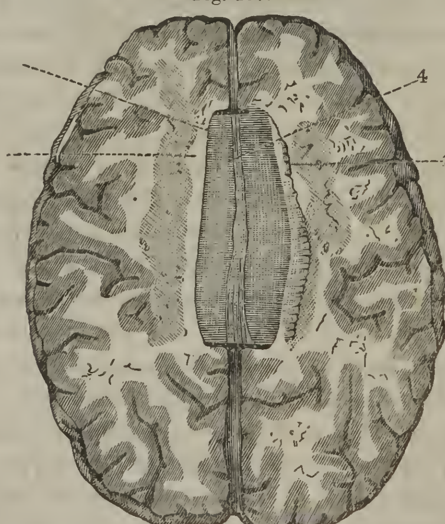
maceration in alcohol or any other fluid capable of coagulating albumen, it is much increased in density, and may be shown to consist of white nerve fibres, held together by a very delicate network of areolar tissue and capillary vessels. The fibres of which it is composed, are either continuations of the spinal cord and nerves at the base of the brain, or else they extend only from one part of the organ to another, for the purpose of connection and association, forming certain parts known as the commissures of the brain.

The largest of these commissural masses is the *great cerebral* or *inter-hemispheric commissure* (named by the older anatomists the *corpus callosum*, upon the supposition that it was the hardest part of the brain), of which one-half of the superior surface has been exposed by the transverse section. This commissure is situated at the bottom of the longitudinal fissure, and it will be observed that it does not extend directly from the inner surface of the hemispheres, but that each hemisphere overhangs it slightly, and admits the introduction of the handle of the scalpel to the distance of at least a quarter of an inch.

Dissection.—If the other hemisphere is now divided upon a level with the one that has already been dissected off, the whole of the superior surface of the commissure will be brought into view. The appearance presented after this section has been made, is termed the *large oval centre* (*centrum ovale majus*).

The great cerebral commissure (Fig. 197) extends from within an

Fig. 197.



Horizontal section of the cerebrum upon a level with the corpus callosum. 1. Outer edge of the corpus callosum, formed by pressing aside the medullary substance of the hemisphere. 2. Medullary or fibrous substance. 3. Upper surface of the commissure. 4. Raphé.

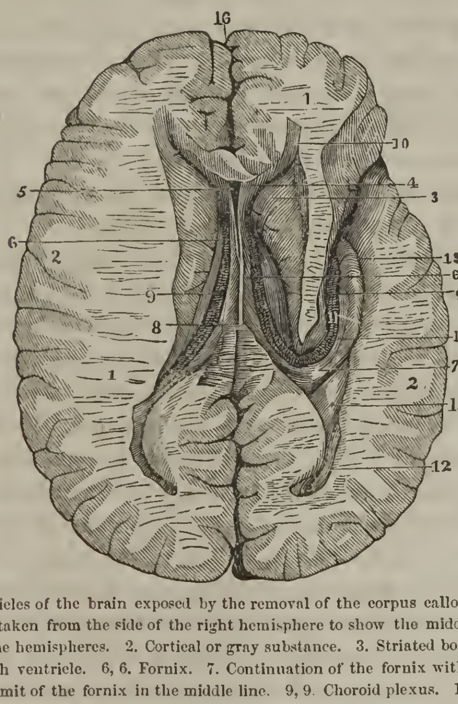
inch and a half of the anterior extremity of the cerebrum, to within two and a half of the posterior. It is about three inches in length, convex above, and marked in the median line by a slight ridge or raphé, which corresponds to the bottom of the longitudinal fissure, and is supposed to indicate the original development of the brain by two distinct halves, and their union in the middle line. Its anterior and posterior extremities are rounded off and turned down. Its under surface forms the roof or ceiling of the lateral ventricles.

The great cerebral commissure is composed entirely of white or medullary substance. Its fibres run transversely between the hemispheres, in the interior of which they may be traced outward in every direction, toward the gray substance of the exterior.

Dissection.—To expose the lateral ventricles, make a longitudinal division of the great commissure upon each side of the raphé, leaving a strip about ¼ of an inch wide along the middle; turn the lateral flaps aside, and cut them off.

The *lateral ventricles* (Fig. 198) are two large, irregular cavities,

Fig. 198.



The lateral ventricles of the brain exposed by the removal of the corpus callosum. A wedge-shaped piece has also been taken from the side of the right hemisphere to show the middle horn. 1, 1. Medullary substance of the hemispheres. 2. Cortical or gray substance. 3. Striated body. 4. Inter-ventricular septum. 5. Fifth ventricle. 6, 6. Fornix. 7. Continuation of the fornix with the great hippocampus. 8. Posterior limit of the fornix in the middle line. 9, 9. Choroid plexus. 10. Anterior extremity or horn of the ventricle. 11. Middle or descending horn. 12. Posterior horn. 13. Great hippocampus. 14. Continuation of the fornix upon the anterior surface of the great hippocampus. 15. Small hippocampus. 16. Forepart of the inter-hemispheric or longitudinal fissure.

flattened in a vertical direction, and separated from each other by an imperfect middle wall of medullary substance, called the *inter-ventricular* or *translucent septum* (*septum lucidum*). This septum consists of two thin laminæ, which are continuous above with the under surface of the great commissure, and inclose, in front, a minute isolated cavity called the *fifth ventricle* (5). In order to see these layers and the included cavity, it is necessary to divide the septum in a horizontal direction by means of scissors. The lower edge of the septum is continuous behind with the superior surface of the triangular white layer called the fornix, and dips down in front very nearly to the base of the brain.

Each lateral ventricle is considered as having a body or main cavity, and three prolongations called horns (cornua). The *anterior horn* (10) is the anterior angle of the cavity; it is short and blunt, and directed obliquely forward and outward, diverging from its opposite fellow. The *posterior horn* (12), situated in the posterior lobe, is long, narrow, and curved, with its concavity presenting toward the middle line; it often reaches within a few lines of the exterior of the lobe. The *middle horn* (exposed by removing a wedge-shaped piece from the side of the hemisphere as represented in Fig. 198), also long and narrow, starts from the body of the cavity immediately in front of the commencement of the preceding, and leads in a very tortuous manner from behind downward, forward, and inward, into the interior of the middle lobe.

Upon the floor of each lateral ventricle, the following objects of interest are seen without any farther dissection:—

The *striated body* (*corpus striatum*, 3) is a large ovoidal mass of gray substance mixed with white fibres, situated in the anterior lobe of the hemisphere, and projecting by its superior surface into the cavity of the ventricle. Its intra-ventricular portion is pyriform in shape; the large extremity occupies the anterior horn, and the small or narrow portion is directed backward and outward, diverging from its fellow of the opposite side. It is covered by the lining epithelium of the cavity, crossed by one or two small veins, and traversed from below and behind, by the fibres of the peduncles of the cerebrum, on their way toward the convex surface of the organ. These latter cannot, however, be seen without making an antero-posterior section of the body, which is not advisable at this stage of the dissection.

Along the inner margin of the striated body, is a small strip of yellowish-white substance called the *horny lamina* (*lamina cornea*); it seems to be a thickening of the epithelium in this situation,

and conceals the large vein of the striated body. Remove the lamina and vein, and a small white line called the *semicircular band* (*tenia semicircularis vel striata*), which separates the striated body from the optic bed, will be brought into view.

The *optic bed* (*thalamus nervi optici*) is situated behind the striated body, and upon the inner side of its posterior or divergent portion. It forms an ovoidal prominence in the body of the ventricle, but being mostly concealed by the choroid plexus and fornix, cannot be satisfactorily examined until these structures have been removed.

The *choroid plexus* (9, 9) is a roll of convoluted vessels, principally minute arteries, which may be considered as consisting of two halves, each of which emerges from the middle horn of its corresponding ventricle, passes forward and inward over the superior surface of the optic bed, and becomes continuous with its fellow of the opposite side beneath the anterior extremity of the fornix. It is covered by a reflection of the epithelial lining of the cavities, and has not unfrequently appended to its border clusters of little spherical bodies, in every respect similar to the Pacchionian bodies found along the superior longitudinal sinus.

The *fornix* (6, 6) is a flattened triangular plane of medullary substance, situated upon the floor of the bodies of the ventricles, with its base presenting backward. Its superior surface is continuous with the inter-ventricular septum: its inferior covers in the third ventricle, from which it is separated by a thin transparent membrane. Its anterior extremity or apex, dips down toward the base of the brain in front of the optic beds, and, if divided, will be found to consist of two rounded legs (crura) or pillars, which may be traced to the white bodies of Willis, and into the optic beds. Considered as originating in the white bodies of Willis, and followed backward, the two pillars ascend between the anterior extremities of the optic beds, expand upon the floor of the ventricles to form the triangular plane, and become continuous upon each side with the two hippocampi found in the middle and posterior horns. Being composed entirely of white fibres, the direction of which is from before backward, the fornix may be looked upon as an antero-posterior commissure of the brain.

Beneath the anterior extremity of the fornix is a considerable opening called the *foramen of Monro*, through which the choroid plexus passes, and the two lateral ventricles communicate with each other and with the third ventricle.

DISSECTION.—Divide the fornix in front, where it arches over the choroid plexus, and turn it back. Upon its under surface will sometimes be seen an impression made by the subjacent vessels, called by the older anatomists the *lyre*, from its fancied resemblance to the musical instrument of that name.

The thin, web-like, transparent membrane, lying beneath the fornix, and now brought into view, is the *choroid membrane* (*velum interpositum*), which seems to be a duplication of the pia mater, pushed into the ventricles beneath the posterior extremity of the great commissure and fornix. It incloses in its margins the choroid plexus, and in the median line, the veins of Galen. It is in relation above with the under surface of the fornix, which it separates from the optic beds, the third ventricle, and the pineal and quadrigeminal bodies below.

The *veins of Galen* are generally two in number; they receive the blood from the veins of the striated bodies and optic beds, pass directly backward beneath the posterior extremity of the fornix, and open into the anterior extremity of the straight sinus of the dura mater. It is around these veins that Bichat supposed a communication to exist between the arachnoid sac and the cavity of the ventricles; but such an opening, at least in the adult, is now known not to exist, the arachnoid being reflected from the circumference of the vein, just beyond the termination of the latter in the straight sinus.

Upon the lower side of the choroid membrane two small vascular fringes may sometimes be noticed, projecting downward between the optic beds, and named the *choroid plexus of the third ventricle.*

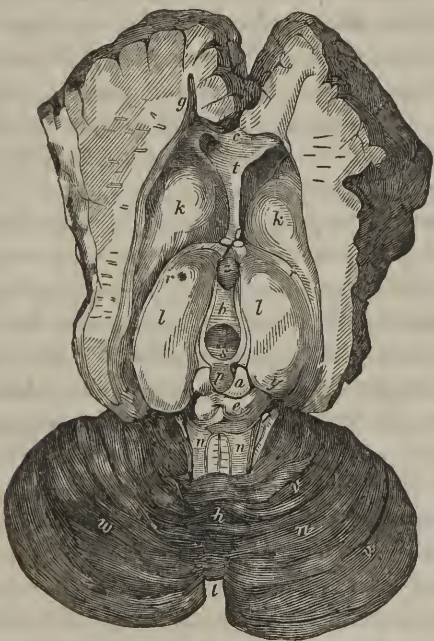
DISSECTION.—Turn the choroid membrane backward, together with the choroid plexus, and dissect it carefully from the pineal body and adjacent parts to which it is closely adherent.

The *optic thalamus* or *bed* (Fig. 199, *l*), the superior surface of which is now clearly brought into view, is a large irregularly ovoidal mass of a light grayish color, occupying the middle parts of the cerebral hemispheres; its long axis is directed antero-posteriorly, and nearly parallel with that of its fellow of the opposite side. It is considered as having four surfaces; the *superior* is smooth, convex, broader behind than before, and forms the floor of the body of the lateral ventricle, after the removal of the fornix, and choroid plexus and membrane; the *external* is continuous with the substance of the corresponding hemisphere and striated body; the *internal* presents toward the median line, and is separated from that of the other side

by the deep fissure, known as the third ventricle; the *inferior* rests upon, and is continuous with the peduncles of the cerebrum, the fibres of which here enter the mass on their way to the superficial parts of the brain. The *posterior extremity* is broad and smooth, and forms the anterior boundary of the middle horn of the lateral ventricle; the *anterior* is narrow, and imbedded, as it were, in the posterior internal surface of the striated body.

Like the striated body the optic bed is one of the primitive ganglia of the brain, and as the former is supposed by some physiologists to be the seat of animal sensation, the latter is thought to be the centre of motion. Although denominated the optic beds, these bodies have no immediate connection with the optic nerves.

Fig. 199.



Section of the cerebrum, showing the upper surfaces of the striated bodies and optic beds, the cavity of the third ventricle, and the upper surface of the cerebellum. *a*, *e*. Quadrigeminal bodies. *a*. Nates. *e*. Testis. *b*. Soft commissure. *e*. Anterior extremity of the corpus callosum cut. *f*. Pillars or legs of the fornix. *g*. Anterior horn of lateral ventricle. *k*, *k*. Striated bodies. *l*, *l*. Optic beds. *z* to *s*. Third ventricle. In front of *z*, anterior commissure. *s*. Posterior commissure. *p*. Pineal body with its peduncles. *n*, *n*. Cerebellar testicular processes. *m*, *m*. Hemispheres of the cerebellum. *h*. Superior vermiform process. *i*. Notch between the hemispheres of the cerebellum behind.

The *third ventricle* (*z* to *s*) is the narrow fissure situated between the optic masses, and extending from the pillars or legs of the fornix

in front, to the quadrigeminal bodies behind. It is roofed in by the choroid membrane and fornix, and its floor is formed by the gray tuber and inter-peduncular space of the base of the brain. Its lateral walls are incrusted by a thin layer of gray substance, and united in the middle by a broad transverse band of the same material, called the *middle* or *soft commissure* (*commissura mollis*, Fig. 199, *b*). By means of this commissure, the ventricle is partially divided into two portions called the *anterior* and *posterior foramina* (*foramen commune anterius et posterius*).

At the anterior extremity of the third ventricle is the *anterior commissure*, a rounded cord of medullary substance, situated deep, just in front of the pillars of the fornix, and extending transversely from the middle lobe and striated body of one hemisphere, to similar parts of the other. It may be seen projecting slightly into the ventricle, by looking between the pillars of the fornix from behind.

The *posterior commissure* is a narrow band of medullary matter, extending between the optic beds at the posterior extremity of the third ventricle. It forms the superior margin of the entrance to the aqueduct of Sylvius; a narrow canal which leads backward from the third to the fourth ventricle.

The third ventricle is prolonged below into the infundibular process of the base of the brain, in the form of a very minute blind canal, through which the old anatomists, not knowing the canal to be closed, supposed the secretions, which they fancied the brain produced, were drained off into the nasal cavities. Above, it communicates with the lateral ventricles through the foramen of Monro, and behind, with the fourth ventricle, by the aqueduct or canal of Sylvius.

The *posterior horn* of the lateral ventricle is a digital prolongation of the cavity into the posterior cerebral lobe. It curves backward with its convexity directed outward, and ends in a blind extremity near the inner surface of the hemisphere posteriorly. It differs in its extent in different individuals, and often in the two hemispheres. Upon its inner wall is a small elliptical prominence called the *small hippocampus* (*hippocampus minor*, Fig. 198, 15), which corresponds to one of the involutions or sulci of the surface of the organ.

Dissection.—To obtain a correct idea of the middle horn of the lateral ventricle, it is requisite to remove a tolerably large wedge-shaped section from the outer side of the hemisphere, involving a considerable portion of the middle lobe, the base of the section presenting externally, as repre-

sented in Fig. 198. In this way the cavity may be opened along its whole course, and viewed from without.

The *middle horn* or *cornu* of the lateral ventricle, is a narrow prolongation of the cavity, commencing just behind the optic bed, and descending forward in a somewhat curved manner, in the middle lobe of the hemisphere toward the base of the brain. Upon its posterior inferior wall will be observed a long prominent roll of medullary substance, called the *great hippocampus* (Fig. 198, 13), which is only the convex portion of one of the involutions of the brain; it terminates at the bottom of the cavity in a nodulated extremity called the *foot* of the hippocampus, which bears some resemblance to the clenched hand. Upon the surface of the great hippocampus is the choroid plexus, the vessels of which enter the cavity from below, and beneath this is the continuation of the outer edge of the fornix, under the name of the *fimbriated body*.

DISSECTION.—Cut away the posterior extremity of one cerebral hemisphere by an incision, extending from just behind the optic bed, downward and forward to the base of the hemisphere. Clear away the vessels and cellular tissue from the parts thus exposed, taking care not to tear away the fourth nerve and the pineal body, and a good view will be had of the following important structures.

The *quadrigeminal bodies* (*corpora quadrigemina*), are four rounded prominences collected into a quadrangular-shaped group, situated behind the third ventricle, and partly between the posterior extremities of the optic thalami. They are separated from each other by a crucial depression, and form, therefore, two pairs denominated the *nates* (Fig. 199, *a*), and *testes* (*e*), of which the former are somewhat the larger, and placed above and a little in front of the latter.

Although apparently composed only of medullary substance, these bodies inclose a quantity of gray or cineritious matter, and are considered as constituting one of the five primitive ganglia of the brain. They are continuous in front with the optic beds, and behind with the cerebellum, and rest upon the peduncles of the brain below.

Surmounting the quadrigeminal bodies in the median line, is the *pineal body* or *conarium* (*p*), a small conoidal-shaped body of gray substance, with its base presenting forward, and attached along the superior internal edge of the optic beds, by two little bridles or peduncles of medullary substance. The structure of this little body is similar to that of the gray substance of the exterior of the brain, except that it generally contains one or more grains of earthy mat-

ter which feels like sand between the fingers, and is found to consist principally of phosphate and carbonate of lime. The function of this little body is as entirely unknown as that of most other parts of the brain. It was the fanciful conceit of Des Cartes that it was the seat of the soul, and that, by the two little peduncles or reins, it governed the movements of the body.

Near the point of junction between the quadrigeminal bodies, and the optic beds on each side, and beneath the posterior margin of the latter, are two grayish elevations, about the size and shape of coffee-grains, called the *geniculate bodies*, of which one is *internal* or nearer the median line, and the other *external*. They are connected to the surrounding parts by medullary substance, and are the principal points of origin of the optic nerves.

The *cerebellar testicular process* (*processus e cerebello ad testes*, Fig. 199 *n*, *n*), is a broad white band of medullary substance extending from the cerebellum to the testes, beneath which its fibres are continued on to the cerebrum. It is oblique in its position, about an inch in length, and a quarter of an inch broad, and convex upon its external surface. It is continuous in the median line with its opposite fellow, by a very thin bridge of grayish substance called the *valve of Vieussens*, which forms the superior wall of the small canal leading from the third to the fourth ventricle. The superior extremity of this valve is connected to the quadrigeminate bodies, or rather to the inferior termination of the vertical groove that separates these bodies, by a well-marked pillar or bridle of white substance. Upon each side of this bridle may be observed the origins of the fourth pair of nerves. The inferior extremity of the valve spreads out to form a part of the superior wall of the fourth ventricle.

THE CEREBELLUM.

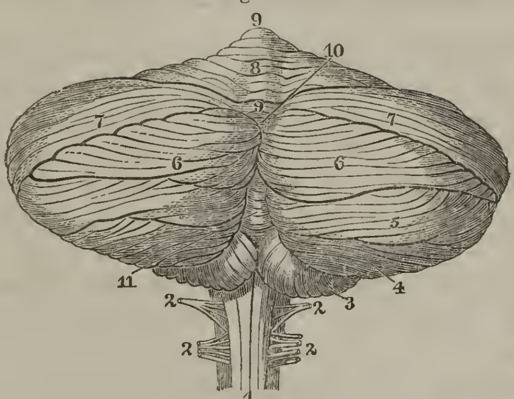
The cerebellum or small brain occupies the posterior fossa of the base of the skull, and is separated from the posterior lobes of the cerebrum by the tentorium, which supports the weight of the latter upon its superior surface. It is transversely oval in shape, but somewhat flattened in a vertical direction, and presents, for consideration, a superior and an inferior surface, and a circumference or margin in which the two surfaces meet. Like the cerebrum, it is divided into two lateral lobes or hemispheres by a median groove or

fissure, which is particularly well marked upon its posterior margin, where it forms a considerable notch occupied by the falciform process of the cerebellum.

The exterior of the cerebellum is not disposed into large convolutions like the surface of the brain, but is marked by numerous fine ridges, which run for the most part, transversely (longitudinally as respects the axis of the organ), and are separated by corresponding grooves or fissures. Upon making a section of the organ, these ridges will be found to consist of concentric laminæ or plates of various sizes, composed in a great measure of gray substance. The gray substance does not, however, form a continuous layer, but is wanting at the bottom of many of the deeper fissures, as may be seen by pressing the plates asunder.

The *superior surface* of the cerebellum is convex, and in contact with the under surface of the tentorium. It is traversed in the median line from before backward, by a crooked elevation or ridge, called the *superior vermiform process* (Fig. 200, 9), which marks

Fig. 200.



Posterior view of the cerebellum, from Solly. 1. Spinal cord. 2, 2. Posterior spinal nerves. 3. Amygdaloid lobules. 4, 5, 6, 7. Right hemisphere of the cerebellum. 8, 9. Superior vermiform process. 10. Commencement of the inferior vermiform process. 11. Pyramid.

the union of the two lobes in this situation. In crossing this process, the concentric plates and intervening furrows make a short curve, convex forward. The *inferior surface* is also convex, and marked in the median line by a deep broad groove called the *valley*, which separates the two lateral *lobes* or *hemispheres*, and is continuous with the notch in the posterior margin. In the bottom of the valley will be seen a continuation of the median ridge above,

called here the *inferior vermiform process* (10); in the course of which, three small elevations present themselves, named, in the order of their succession from behind forward, the *pyramid*, *uvula*, and *nodule*. Upon the sides of the valley opposite the uvula are two large rounded prominences, called, from their resemblance to a pair of swollen tonsils, the *amygdaloid* or *tonsillitic lobules*. In front of these, and more external, are the two smaller masses called the *pneumogastric lobules* or *flocculi*, which are connected to the cerebellar hemispheres by a delicate white peduncle, and continuous with each other by transverse white fibres forming a kind of crest or plane, convex before and concave behind, called the *inferior medullary veil* (*velum*). This veil constitutes a part of the posterior inferior wall of the fourth ventricle.

Besides these, there are other divisions, such as the *digastric*, *gracilis*, and *semilunar lobes*, mentioned by authors as occurring upon the inferior surface; but it is only necessary, in a work of this kind, to mention their names.

DISSECTION.—Make a clean vertical division of the cerebellum from behind down to the oblong medulla, so as to lay open the fourth ventricle.

The *fourth ventricle* of the brain is an elongated quadrangular or lozenge-shaped cavity, measuring about an inch in length, and half an inch in breadth, situated behind the oblong medulla, and between the peduncles of the cerebellum. Its inferior anterior wall, formed by the posterior surface of the oblong medulla, is flattened and diamond-shaped, and traversed in the median line by a continuation of the posterior fissure of the spinal cord, which, at the inferior extremity of the cavity, presents a minute angular depression, called the *cavity of Aurantius* (Fig. 202). This surface is incrusted with a thin coating of gray substance, through which may be seen numerous fine, transverse, white fibres converging toward the lateral corners of the cavity. These are the origins of the auditory nerve, and vary very much in their distinctness in different individuals.*

The posterior superior wall of the fourth ventricle is hollowed out, as it were, of the anterior margin of the cerebellum, which is here continuous above with the cerebellar testicular processes and valve of Vieussens, and below with the tonsillitic and pneumogastric lobes.

The anterior or superior extremity of the cavity is continuous

* The longitudinal fissure, cavity of Aurantius, and transverse fibres, bear some obscure resemblance to a quill pen, and hence, the older anatomists denominated this surface the *calamus scriptorius*.

with the canal leading from the third ventricle (*aqueduct* or *canal of Sylvius*), which may be readily seen by passing a probe or grooved director from above, and dividing the superjacent valve. The inferior extremity is imperfectly closed by the pneumogastric lobes, between which Magendie demonstrated the communication of the cavity with the sub-arachnoid space; the arachnoid membrane being here stretched across from the hemispheres of the cerebellum to the spinal cord, so as to form a considerable interval, occupied for the most part by areolar tissue and bloodvessels. At this point, also, the pia mater enters the ventricle, and forms a small vascular fringe, somewhat similar to the choroid plexus of the lateral ventricles.

If the student will now examine the sides of the vertical section already made, he will observe the peculiar arrangement of the gray and white substances of the organ. It has been already stated that the gray or cortical substance is disposed in the form of plates or lamellæ of various sizes, but it will now be seen that it is properly the medullary substance which forms these plates, the gray matter only incrusting their lateral surfaces and free edges. It is this lamellar arrangement of the white substance, that gives to the section the beautiful arborescent appearance called the *arbor vitæ*.

In the midst of the central mass of white substance from which the lamellæ are prolonged, but somewhat nearer the superior than the inferior surface of the organ, is a small yellowish body, called the *rhomboid body* or *dentatum*. It consists of a thin, irregularly involuted capsule of gray substance, filled with a plexiform mass of medullary fibres, which enter and emerge from it at all points.

The cerebellum is continuous with the cerebrum through the cerebellar testicular processes (superior peduncles of the cerebellum), and with the oblong medulla by means of the restiform bodies (inferior peduncles), hereafter to be described. The two hemispheres, although intimately bound together by continuity of tissue, are also provided with a separate commissure already mentioned under the name of the Varolian bridge, the fibres of which, as they leave the organ on either side, are collected into a large well-marked bundle called the *middle peduncle* of the cerebellum.

The *Varolian bridge* (*pons Varolii*) or *annular protuberance* (Fig. 196, *o*), is a large quadrangular convex body situated in front of and above the oblong medulla. It is continuous with the hemispheres of the cerebellum by the middle peduncles, and is composed almost entirely of the convergent white fibres of the organ. It rests in front upon the basilar process of the occipital bone, is closely invested with

dense pia mater, and slightly grooved in the median line for the basilar artery. Its superficial fibres are collected into distinct fascicles or bundles, and when these are turned aside, a deeper group is discovered mixed with gray substance, and with the anterior fibres of the spinal cord on their way to the cerebrum. Upon each side of and about half an inch from the median line, its fibres separate to give passage to the fifth nerve, which, although apparently originating from the bridge itself, comes from the inclosed continuation of the spinal cord. Crossing its inferior margin and resting upon its convex surface, will also be observed the sixth pair of nerves.

THE OBLONG MEDULLA.

The oblong medulla (*medulla oblongata*), although generally considered as one of the divisions of the brain, is only the expanded upper extremity of the spinal cord. Taken alone, it is an irregularly conoidal body, the apex of the cone truncated and continuous with the spinal cord, and the base defined above by the Varolian bridge, although really continued on into the cerebrum and cerebellum. It is considered as measuring about twelve or fourteen lines in length, although its limits are altogether arbitrary, there being no boundary line between it and the rest of the spinal cord. When the organ is in its place, it rests upon the basilar process of the occipital bone, and is overhung above and behind by the hemispheres of the cerebellum. It is closely invested with dense pia mater, which, being difficult to remove without tearing up the origins of several nerves, should be dissected from only one lateral half of the organ.

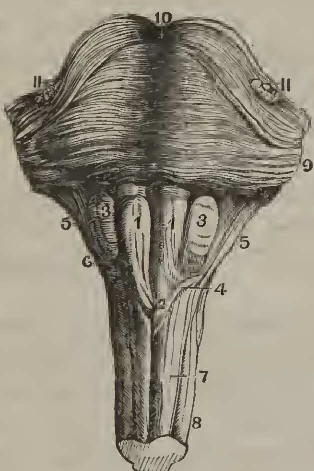
The anterior and posterior surfaces of the oblong medulla are marked by continuations of the anterior and posterior longitudinal fissures (Figs. 201 and 202) of the spinal cord, by which the organ is divided into two lateral halves or columns. The lateral halves are again divided by shallow furrows into four small prominences or bodies, named respectively from before backward, the anterior pyramidal, olivary, restiform, and posterior pyramidal bodies.

The *anterior pyramidal body* (Fig. 201, 1) is a small, rounded, vertical, columnar mass or fascicle of medullary fibres, forming the anterior division of the lateral half of the oblong medulla. It is about an inch in length, prominent and defined above by the lower margin of the Varolian bridge, from which point it gradually sub-

sides to its lower termination upon the general surface of the spinal cord. It is separated from its fellow of the opposite side by the anterior spinal fissure, but upon gently pressing the two asunder, it will be noticed that, about three-fourths of an inch below the Varolian bridge, there is an interchange or decussation of fibres, several small bundles crossing the fissure obliquely from one side to the other. The anterior pyramids consist of the anterior fibres of the spinal cord, which, although apparently limited above by the Varolian bridge, are continued on behind this body to constitute the peduncles or crura of the cerebrum.

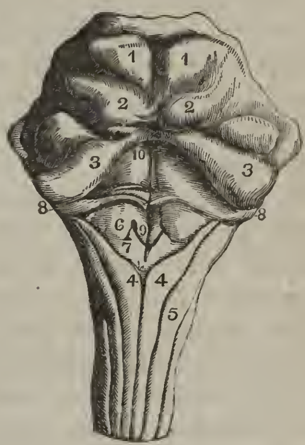
The *olivary body* (Fig. 201, 3) is external to the pyramidal, from which it is separated by an indistinct furrow. It is quite prominent, regularly convex, of a well-defined ovoidal outline, and about half an inch in length; it is composed of medullary substance in-

Fig. 201.



Anterior view of the oblong medulla, after Quain. 1, 1. Pyramidal bodies. 2. Point at which they decussate. 3, 3. Olivary bodies. 4. Fibres that run from the anterior column to the cerebellum. 5, 5. Restiform bodies. 6. Arciform fibres. 7. Anterior columns or tracts of spinal cord. 8. Lateral columns. 9, 10. Varolian bridge. 11, 11. Roots of the fifth pair of nerves.

Fig. 202.



Posterior view of the oblong medulla, the cerebellum having been cut away, after Quain. 1, 1. Nates. 2, 2. Testes. 3, 3. Cerebellar testicular processes or superior cerebellar peduncles cut close. 4, 4. Posterior pyramids. 5. Restiform bodies. 6, 10. Floor of the fourth ventricle. 7. Roots of the auditory nerve. 8. Prominence connected with the origin of the hypoglossal nerve. 9. Continuation of the posterior fissure of the spinal cord.

closing a small quantity of the gray substance. Its medullary portion consists in a great measure of fibres from the anterior part of

the spinal cord, which here curve a little backward and outward, and subsequently appear beneath the gray substance of the floor of the fourth ventricle, whence they turn forward again, and go to contitute a part of the peduncles of the cerebrum. Upon the surface of these longitudinal fibres, and covering the lower extremity of the body, are a few commissural fibres, which seem to originate from the anterior pyramids, and, curving backward in the form of arches with their concavities presenting upward, terminate in the restiform bodies. They are called the *arciform fibres* (6), and are not always sufficiently well developed to be readily recognized with the naked eye. The gray substance forming the interior of the body is very small in quantity, and continuous with the mass of gray substance forming the centre or axis of the spinal cord.

The *restiform* body* (Fig. 201, 5, and 202, *d*) is a rounded, pillar-like mass of medullary substance, situated behind the olivary body, and forming the lateral inferior boundary of the fourth ventricle. It is oblique in its position, divergent from its opposite fellow, and consists entirely of fibres from the posterior part of the spinal cord. Traced from below, it ascends somewhat outward and backward, and enters the cerebellum, constituting on each side the inferior peduncle of this organ.

The restiform body is separated from the olivary by a well-marked vertical groove or furrow, from the bottom of which several nerves, hereafter to be mentioned, take their origin. This furrow is usually denominated *Bell's† respiratory tract.*

The *posterior pyramidal body* (Fig. 202, *p*) is a long, narrow bundle of medullary substance, situated internally to the restiform body, and separated from its fellow of the opposite side by the posterior median fissure of the oblong medulla, and the inferior angle of the fourth ventricle. It extends the whole length of the spinal cord, but is seen distinctly only in the lower part of the fourth ventricle, the floor of which it assists in forming. The ultimate disposition of its fibres is not yet determined.

Structure.—The oblong medulla, like the rest of the spinal cord, is composed externally of medullary substance, inclosing a central axis of gray substance. The medullary substance consists principally of longitudinal fibres, the anterior of which become continuous above with the peduncles of the cerebrum, and the posterior with

* *Restis*, a rope. † Sir Charles Bell, of Edinburgh.

the inferior peduncles of the cerebellum. The gray substance occupies the centre of the organ, and, upon a transverse section, presents the appearance of two irregular crescents directed antero-posteriorly, and united by their convexities. In addition to this, there is a small mass of gray substance in each olivary body, continuous, however, with the central column.

ORIGINS OF THE CRANIAL NERVES.

The nerves originating from the base of the brain, were considered by Willis* as consisting of only nine pairs, which he named numerically, the first, second, third, and so on, commencing with the most anterior; and although it has been for some time established that the actual number is twelve, yet the former enumeration has become so common among anatomists, that it cannot at present be entirely thrown aside. Other classifications, however, may be followed, and among the most rational, is that proposed by Sir Charles Bell, who divided the twelve pairs into four groups, according to their supposed function. These groups are:—

1. Nerves of special sense.
2. Single-rooted motor nerves.
3. Double-rooted compound nerves of motion and sensation.
4. Respiratory nerves.

The first class embraces *three* pairs, namely, the olfactory, optic, and auditory; the second, *three* pairs, the common motor nerves of the eyes (*motores oculorum*), the nerves of the abductor muscles of the eyes (*abducentes*), and the hypoglossal or motor nerve of the tongue; the third class, *one* pair, the trigeminal or trifacial; and the fourth, *five* pairs, the trochlear (*patheticus*), the facial (*portio-dura*), the glosso-pharyngeal, the pneumogastric (*par vagum*), and the spinal accessory.

A more recent, simple, and general classification, is that into three groups: 1, afferent nerves, which carry impressions to the nervous centre; 2, efferent nerves, which convey impressions from the centre; and 3, compound nerves, which carry impressions both to and from the centre.

For purposes of demonstration, the true numerical classification

* Thomas Willis, of England, born A. D. 1621, died, 1674.

is probably the most convenient. But before commencing dissection, the student is advised to examine the subjoined table, in which the several nerves are arranged numerically with their common names affixed. He will here notice that what was formerly called the seventh pair, consists of two, and what was called the eighth, of three separate and distinct pairs, thus making altogether twelve instead of nine pairs.

1st pair.	The olfactory nerves.	
2d pair.	The optic nerves.	
3d pair.	The common motor nerves of the eyes (*motores oculorum*).	
4th pair.	The pathetic (*pathetici*), or trochlear nerves (*trochleares*).	
5th pair.	The trigeminal (*trigemini*) or trifacial nerves.	
6th pair.	The abducent nerves (*abducentes*).	
7th pair.	The auditory nerves (*portio mollis*).	7th pair of Willis.
8th pair.	The facial nerves (*portio dura*).	
9th pair.	The glosso-pharyngeal nerves.	8th pair of Willis.
10th pair.	The pneumogastric nerves (*par vagum*).	
11th pair.	The spinal accessory nerves.	
12th pair.	The hypo-glossal nerves.	9th pair of Willis.

Dissection.—The base of the brain having been left untouched, except for the removal of the membranes and bloodvessels, should be inverted, and the origins of the nerves separately examined.

First Pair (Fig. 196, 1).—The first or olfactory nerve of each side is situated in a longitudinal depression between two convolutions, upon the under surface of the anterior lobe of the cerebrum, very near the anterior termination of the inter-hemispheric fissure. It is about an inch in length, triangular prismatic in shape, bulbous at its anterior extremity, and connected, by its posterior extremity, to the anterior perforated space of the base of the cerebrum. Its origin consists of three tolerably distinct roots, which diverge from each other in a lateral direction. The *external* and longest root, may be traced along the anterior border of the perforated space as far as the fissure of Sylvius, where its fibres become blended with the central medullary substance of the anterior lobe. The *middle* root consists of an internal bundle of white fibres, covered with gray substance, the latter continuous with the cortical portion of the anterior lobe in front of the perforated space, and the former with the striated body. The *internal* root cannot be readily seen, except in a brain sufficiently hardened to allow of laceration in the course of its fibres;

it consists of medullary fibres, which are continuous with the posterior part of the anterior lobe.

The anterior or bulbous extremity of the nerve is small in the human subject, but very large in many of the inferior animals, in some of which it constitutes the larger part of the cerebral mass. It consists in a great measure of gray substance, through which the white fibres, that constitute the main trunk of the nerve, pass to their distribution.

Distribution.—The branches of the olfactory nerve are very numerous; they all originate from the under surface of the bulbous extremity, and passing through the holes in the cribriform plate of the ethmoid bone, are distributed solely to the lining membrane of the nose.

As its name indicates, it is the special nerve of the sense of smell, and belongs, therefore, to the afferent class.

Second Pair (Fig. 196, 2).—The optic nerve is remarkable for its large size, and for the crossing or decussation of its fibres with those of its fellow of the opposite side. In the fresh brain its origin cannot be satisfactorily demonstrated, but where the organ has been well hardened, three distinct roots may be discovered; one comes from the quadrigeminal bodies, another from the external geniculate body, and the third from the optic thalamus. From these three points the fibres converge to form a flattened cord, which, winding around the outer and inferior surface of the cerebral peduncle, makes its appearance upon the base of the brain, just outside of the gray tuber (*tuber cinereum*), along the margin of which it passes forward and inward, to form with its opposite fellow the optic crossing or commissure.

The *commissure*, or *chiasm* (*c*), as it is sometimes called, is situated in the middle line, in front of the gray tuber, and rests upon the olivary process of the sphenoid bone. The interchange of fibres involves only about two-thirds or three-fourths of each nerve, the fibres of the outer third or fourth, being continued on to the nerve of the same side.* The decussation having taken place, the nerve assumes a more cylindrical form, and directs its course forward and

* The author has never been able to discover the fibres described by Mayo, as running from one optic tract to the other, along the anterior and posterior margins of the commissure, nor the accessory fibres of the root coming from the tuber cinereum mentioned by Vicq d'Azyr.

outward toward the optic foramen, being invested by a tubular prolongation of the dura mater and the arachnoid membrane.

Distribution and Function.—Having traversed the optic foramen in company with the ophthalmic branch of the internal carotid artery, the optic nerve perforates the sclerotic and choroid coats of the eye, and becomes spread out upon the surface of the vitreous humor, in the form of an exceedingly delicate membrane, known as the retina. It is the special nerve of the sense of sight, and belongs, therefore, to the afferent class, its office being to report to the brain impressions made upon the retina.

Third Pair (Fig. 196, 3).—The third or common motor nerve of the eye (*motor oculi*) is much smaller than the preceding. It has its origin from the inner side of the cerebral peduncle, beyond which some of its fibres are said to have been traced into the quadrigeminal bodies, valve of Vieussens, and anterior pyramids, and into the dark substance (*locus niger*) found in the centre of the peduncle.

Distribution and Function.—From its point of connection with the brain, the third nerve is directed forward toward the sphenoidal fissure. Before traversing this, it receives a few filaments from the cavernous plexus of the sympathetic nerve, and divides into two branches, that enter the orbit between the two heads of the abductor muscle of the eye. Within the orbit it divides into numerous branches, which are distributed principally to the superior, internal, and inferior straight, and inferior oblique, muscles of the eye, and to the elevator muscle of the upper eyelid.

The third nerve is simply motor or efferent in its function, as might be inferred from its being distributed only to muscles.

Fourth Pair (Fig. 196, 4).—The fourth, called also the pathetic or trochlear nerve, the smallest of the cranial nerves, is about the size of a tolerably coarse sewing-thread. It is found upon the base of the brain, immediately to the outer side of the cerebral peduncle, and just in front of the Varolian bridge. It originates from the cerebellar testicular process, beneath the quadrigeminal bodies, and passing forward along the under surface of the free margin of the tentorium, it perforates the outer wall of the cavernous sinus, and enters the orbit through the upper part of the sphenoidal fissure. Within the wall of the sinus it receives a few small filaments from the sympathetic nerve, and "is not unfrequently blended with the ophthalmic divisions of the fifth." Having traversed the sphenoidal

fissure, it passes along the roof of the orbit, and is distributed to the superior oblique or trochlear muscle of the eye.

The fourth nerve, although strictly motor or efferent, was placed by Sir Charles Bell in his respiratory class, simply from the fact that, in difficult respiration, the eye is observed to turn downward and outward, owing mainly to the contraction of the superior oblique muscle to which this nerve is distributed.

Fifth Pair (Fig. 196, 5).—The fifth, trigeminal, or trifacial, the largest of the cranial nerves, originates *apparently* from the inferior lateral surface of the Varolian bridge. It is found to consist of two distinct bundles, one quite small, and the other large, which are in fact two distinct roots, the former motor or efferent in its function, and the latter sensory or afferent. Traced through the bridge to their *real* origin, the sensory root has been followed into the posterior tract of the spinal cord, forming a part of the floor of the fourth ventricle; and the motor root to the continuation of the anterior tract inclosed by the bridge.

Distribution.—Leaving the Varolian bridge, the nerve is directed forward over the superior surface of the apex of the petrous bone, the two roots lying side by side, but totally distinct from each other. Here the sensory root becomes spread out to enter the ganglion of Gasser, beneath which the motor division continues on to its destination.

The *Gasserian ganglion*, second in point of size to the semilunar ganglion, which is the largest in the body, is situated upon the superior surface of the inner extremity of the petrous bone, beneath and tolerably closely attached to the dura mater. It is flattened from above downward, semilunar or crescentic in form, and of a dark gray color. It receives the large root of the trigeminal together with a few filaments from the sympathetic nerve. From its convex border which presents forward, are given off three main branches, namely, the ophthalmic, superior maxillary, and inferior maxillary nerves. The *first* of these leaves the cavity of the skull through the sphenoid fissure, and is distributed to different parts within the orbit, the skin of the forehead, and the lining membrane of the nose. The *second* traverses the round foramen of the sphenoid bone, and is eventually distributed to the skin of the cheek and temple, to the palate and the teeth of the upper jaw. The *third* is joined by the motor root before mentioned, with which it passes through the oval opening of the sphenoid bone, the motor portion to be distributed

principally to the muscles of mastication, and the sensory, to the teeth of the lower jaw and mucous membrane of the tongue.

The first and second branches of the fifth are sensory or afferent nerves, but the third, consisting in part of the motor root, is compound.

Sixth Pair (Fig. 196, 6).—The sixth nerve (*abducens*) has a middle place in point of size between the third and fourth. It originates from the anterior pyramidal body, immediately beneath the posterior margin of the Varolian bridge, passes directly forward between the bridge and the basilar process of the occipital bone, perforates the cavernous sinus, enters the orbit through the sphenoidal fissure, and is distributed solely to the abductor or external straight muscle of the eye. Its function is strictly motor or efferent.

Seventh Pair (Fig. 196, 7).—The seventh or auditory nerve (*portio mollis*), is just external to the sixth, and in close contact with the eighth, and with the lower margin of the Varolian bridge. It originates from the floor of the fourth ventricle by numerous delicate fibres, which converge from the sides of the median fissure toward the outer angle of the cavity; here the fibres become collected into a bundle, which winds around and receives a few fibres from the upper extremity of the restiform body, and meeting the facial just below the margin of the Varolian bridge, is continued along with it, a small arterial twig intervening, to the internal auditory meatus upon the posterior face of the petrous bone. Within the meatus it leaves the facial, and, dividing into two branches, is distributed upon the parts concerned in hearing. The seventh belongs to the afferent class, and is the special nerve of the sense of hearing.

Eighth Pair (Fig. 196, 7).—The eighth or facial nerve originates from the upper extremity of the groove, between the olivary and restiform bodies, with both of which its fibres are said to be connected. From this point it is directed forward by the side of the preceding, to the internal auditory meatus, whence it descends through the stylo-mastoid foramen to reach the muscles of the side of the face. In its course, it sends off numerous branches hereafter to be mentioned.

Although strictly a motor or efferent nerve, the facial was classed among Bell's respiratory nerves, both on account of its origin, and

its distribution to muscles which are to some extent concerned in respiration.

Ninth Pair (Fig. 196, 8).—The ninth or glosso-pharyngeal nerve originates from the groove between the olivary and restiform bodies, just below the root of the facial, and its fibres are continuous, in all probability, with both the anterior and posterior tracts of the spinal cord. Directed horizontally outward, it traverses the jugular foramen lying somewhat in front of the two succeeding, descends forward, being situated deep in the upper part of the neck, and is distributed to the mucous membrane and muscles of the pharynx and base of the tongue. Its fibres belong, in all probability, to both the motor and sensory divisions.

Tenth Pair (Fig. 196, 8).—The tenth or pneumogastric nerve (*par vagum, nervus vagus*), so called from its furnishing branches to the lungs and stomach, originates below the preceding, by a series of small roots from the bottom of the groove separating the olivary and restiform bodies, most of the fibres coming from the latter organ. These rootlets are directed outward, and converge toward the jugular foramen, through which they leave the cranium in the form of a flattened cord. It occupies the same sheath with the eleventh or spinal accessory, and is separated from the glosso-pharyngeal by a small process of the dura mater. Having emerged at the base of the skull, it descends the side of the neck in the common sheath of the internal and primitive carotid arteries and jugular vein into the thorax, through which it reaches the abdomen, and distributes branches to the pharynx, larynx, trachea, lungs, heart, stomach, and several other parts.

Eleventh Pair (Fig. 196, 8″).—The eleventh or spinal accessory nerve is enumerated with the cranial nerves, but originates from the spinal cord, as low as the third or fourth cervical vertebra. Its origin consists of a series of delicate roots coming from the lateral part of the cord just in front of the posterior roots of the spinal nerves; these bend forward and unite to form a medium-sized bundle, which enters the cavity of the cranium through the occipito-spinal foramen, and then turns outward toward the jugular foramen, where it becomes placed in the same sheath with the pneumogastric. Leaving the skull through this opening, it is directed outward and backward to supply some of the muscles on the side of the neck.

TWELFTH PAIR (Fig. 196, 9).—The twelfth, called also the hypoglossal or lingual nerve, arises by six or eight slender filaments from the groove separating the pyramidal and olivary bodies, and is therefore upon a plane anterior to the ninth, tenth, and eleventh, and in a line with the anterior or motor roots of the spinal nerves. From its origin it is directed outward and forward. It leaves the cranium, through the anterior condyloid foramen, to be distributed to the muscles of the tongue. Its function is simply motory.

THE FACE.

Both sides of the face being precisely alike, the most profitable mode of procedure is to dissect one side for the muscles, and afterward the other for the vessels and nerves.

MUSCLES OF THE FACE.

The muscles of the face compose two very distinct sets, a superficial, and a deep; those of the former belong to the three apertures, the mouth, nose, and orbits of the eyes, and have each but one bony attachment; those of the latter are intended to act upon the lower jaw for the purposes of mastication.

The superficial set comprises the orbicular or sphincter muscle of the eye, the corrugator of the eyelid, the nasal pyramidal, the naso-labial elevator, the compressor of the nose, the smaller and greater zygomatic, the elevator of the angle of the mouth, the depressor of the superior lip, the depressor of the angle of the mouth, the elevator of the lower lip, the orbicularis or sphincter of the mouth,* and the buccinator. They are remarkable for their pale color, and the free admixture of adipose substance with their fibres.

DISSECTION.—Make a median incision, involving only the skin, from the top of the forehead to the point of the chin, and from the middle and two extremities of this make three others, the superior extending to a level with the top of the ear, the middle to the external auditory meatus, and the inferior along the base of the lower jaw to its angle. Dissect off the superior flap first, and next the lower, taking particular care to keep the edge of the knife as close to the under surface of the skin as possible, to avoid cutting the muscles with which it is intimately connected. Next, remove the adipose substance with the knife or forceps, or both, as is most convenient.

* The orbicular muscle of the mouth has no bony attachment.

The ORBICULAR OR SPHINCTER MUSCLE OF THE EYELID (*orbicularis palpebrarum*, Fig. 203, 4) is a thin but extensive plane of muscular fibres, surrounding the base of the orbit, and extending over upon the eyelids. It is transversely oval in shape, and continuous at its internal extremity with a small fibrous cord called the *ocular tendon* (*tendo oculi*), which arises from the ascending process of the superior maxillary bone, passes nearly horizontally outward, and at the internal angle of the eyelids bifurcates to be inserted into their tarsal cartilages. The muscular fibres may be considered as taking their origin from the upper edge of this tendon, and from the internal angular process of the frontal bone. Thence they proceed in a curved manner across the upper eyelid, the adjacent part of the frontal bone, and anterior edge of the temporal aponeurosis, nearly as far as the middle of the temple, where, turning upon themselves, they curve inward in front of the malar and superior jawbones, and across the lower lid, to be inserted into the lower edge of the tendon and inner third of the inferior margin of the orbit. The muscle is covered only by the skin, and is remarkable for being very pale and indistinct where it crosses the eyelids.

USE.—To close the eyelids and draw down the brow, which it does by acting from its tendinous and bony attachment as a fixed point.

The ocular tendon lies directly in front of the upper portion of the lachrymal sac, and being readily felt through the skin, is the guide to the surgeon when it becomes necessary to lay open this cavity for the purpose of discharging accumulated fluid, or penetrating the nasal duct.

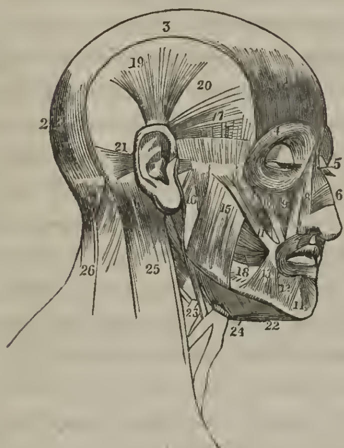
The CORRUGATOR or CONTRACTOR OF THE EYEBROW (*corrugator supercilii*) is a small and often indistinct muscular fascicle situated beneath the inner portion of the preceding and anterior extremity of the occipito-frontal muscle, resting upon the superciliary ridge of the frontal bone. It arises from the internal angular process of the frontal bone, passes upward and outward, and is inserted into the skin of the middle of the eyebrow, blending with the fibres of the muscles by which it is covered.

USE.—To draw the eyebrow toward the root of the nose, as in frowning.

The NASAL PYRAMIDAL (*pyramidalis nasi*, Fig. 203, 5) is a long, thin, triangular strip of muscle, continued down from the inner edge

of the occipito-frontal upon the side of the bridge of the nose, where it spreads out into an aponeurosis, which is inserted into the edge of the next muscle.

Fig. 203.



Muscles of the face. 1. Frontal portion of the occipito-frontal. 2. Its posterior or occipital portion. 3. Its aponeurosis. 4. Palpebral sphincter, which conceals the corrugator of the eyebrow, and tensor of the lids. 5. Nasal pyramidal. 6. Nasal compressor. 7. Sphincter of the mouth. 8. Naso-labial elevator. 9. Proper elevator of the upper lip. 10. Small zygomatic. 11. Great zygomatic. 12. Depressor of the lower lip. 13. Depressor of the angle of the mouth. 14. Elevator of the lower lip. 15. Superficial portion of the masseter. 16. Its deep portion. 18. Buccinator. 19. Elevator of the ear. 20. Temporal aponeurosis which conceals the temporal muscle. 21. Retractor of the ear. 22. Anterior belly of the digastric—the tendon is seen passing through the loop formed by the cervical fascia. 23. Stylo-hyoid muscle. 24. Milo-hyoid muscle. 25. Sterno-mastoid muscle. 26. Upper part of the trapezius—the muscle between 25 and 26 is the splenius.

USE.—To raise the skin upon the side of the nose, and to draw down the inner end of the eyebrow.

The NASO-LABIAL ELEVATOR (*levator labii superioris alæque nasi*, Fig. 203, 8), also small and poorly defined, arises by a narrow extremity from near the end of the nasal process of the upper jaw, and the adjacent part of the lower edge of the orbit. It becomes broader as it descends, and is inserted into the side of the nostril and upper lip.

USE.—To elevate the lip and dilate the nostril.

The NASAL COMPRESSOR (*compressor nasi, triangularis nasi*, Fig. 203, 6) lies partly under the preceding, and is very thin, small, and triangular. It originates by a narrow extremity from the canine fossa, spreads out over the side of the nostril, and is inserted by a thin aponeurosis into the middle line of the nose.

USE.—To compress the nostril when widely dilated, and to assist in dilating it when much compressed.

The SMALL ZYGOMATIC (*zygomaticus minor*, Fig. 203, 10) when present, which is by no means always the case, is a slender muscular bundle, arising from the upper part of the malar bone, and inserted into the upper lip near its angle.

USE.—To elevate the lip.

The GREAT ZYGOMATIC (*zygomaticus major*, Fig. 203, 11), long and cylindrical, arises from the lower part of the malar bone externally to the preceding, descends forward and inward, and is inserted into the angle of the mouth. It is partly covered above by the orbicular muscle of the eye, and lies upon the buccinator and masseter.

USE.—To draw the corner of the mouth upward and outward, as in laughing.

The ELEVATOR OF THE UPPER LIP (*levator labii superioris*, Fig. 203, 9), broad, thin, and quadrangular, arises from the inner half of the lower margin of the orbit, and is inserted into the skin of the upper lip at a little distance from the angle. It is covered above by the orbicular muscle and the zygomatic vessels, and a large quantity of fat, and covers the branches of the infra-orbital vessels and nerves as they emerge at the infra-orbital foramen.

USE.—To elevate the upper lip.

The DEPRESSOR OF THE UPPER LIP (*depressor labii superioris alæque nasi*), very small, may be seen by everting the lip and removing the mucous membrane by the side of the frænum. It arises from the myrtiform fossa above the incisor and canine teeth, ascends, and is inserted into the skin of the upper lip and cartilage of the nose. It is covered by the elevator and orbicular muscles.

USE.—To draw down the upper lip and press it against the teeth.

The DEPRESSOR OF THE ANGLE OF THE MOUTH (*triangularis oris*, Fig. 203, 13), flat and triangular, arises broad from the lower border and oblique line of the inferior maxilla, and, becoming narrow as it ascends, is inserted into the angle of the mouth, blending with the fibres of the orbicular muscle.

USE.—To draw the angle of the mouth down.

The DEPRESSOR OF THE INFERIOR LIP (*quadratus menti*, Fig. 203, 12) is quadrilateral, and situated upon the inner side of the preceding. It arises from the lower jaw just above its base near the symphysis, ascends, its innermost fibres decussating with those of the opposite side, and is inserted into the skin of the lower lip. It is covered only by the skin, and lies upon the orbicular muscle, and the mental vessels and nerves.

USE.—To depress the under lip.

The ELEVATOR OF THE LOWER LIP (*levator labii inferioris*) is small and conoidal, and may be seen by everting the lip and removing the mucous membrane near the frænum. It arises from the alveolar processes of the incisor teeth by its pointed extremity, and, becoming expanded as it descends, is inserted into the skin of the chin.

USE.—To draw up the lower lip and skin of the chin.

The ORBICULAR or SPHINCTER MUSCLE OF THE MOUTH (*orbicularis oris*, Fig. 203, 7) consists of two curved planes of fibres corresponding to the upper and lower lips, their concavities presenting toward each other, and their extremities decussating at the angles of the mouth. Considered as one muscle, it is of an elliptical form, situated between the skin and mucous membrane. Its internal edge corresponds to the margins of the lips, and its external is blended with the various muscles which here have their insertion.

USE.—To approximate the lips, and to assist in the various modifications of this action of which these organs are capable.

The BUCCINATOR (Fig. 203, 18) is a broad, thin, irregularly quadrilateral layer of fibres, situated in the cheek or lateral wall of the cavity of the mouth. Its superior margin is attached along the alveolar arch of the upper jaw, as far forward as the first molar tooth; its inferior to the corresponding part of the lower jaw, and its posterior or external to the intermaxillary ligament.* From these points the fibres pass horizontally forward, and are inserted into the orbicular muscle at the angle of the mouth; just before reaching their insertion a decussation takes place, the uppermost fibres turn downward to the lower lip, and the lowermost upward to the superior, the former being apparently continuous with the inferior plane of the orbicular muscle, and the latter with the superior. It is overlapped behind by the masseter muscle and ramus of the lower jaw, and more anteriorly by the two zygomatic muscles; it is lined internally by the mucous membrane of the mouth, and is perforated behind by the duct of the parotid gland.

USE.—To draw the angles of the mouth outward, and when the cheeks are expanded, to bring them back again to their natural position; it is, therefore, the principal muscle concerned in blowing. It also assists very materially in pressing the food from one part of the

* This is a well-defined tendinous arch, stretched from the pterygoid process of the sphenoid to the coronoid process of the inferior maxilla.

mouth to the other, and particularly in dislodging it from between the gums and cheek.

The superficial muscles of the face, with the exception of the tendinous portion of the orbicular muscle of the eye, which is the guide to the operation for opening the lachrymal sac, are of little or no surgical importance, but in a physiological point of view, they are among the most interesting in the body. The next group, comprising the masseter, temporal, and two pterygoids, are the principal muscles of mastication.

The MASSETER MUSCLE (Fig. 203, 15 and 16) is short, thick, quadrilateral, and situated upon the outer surface of the ramus of the lower jaw. It originates by fleshy and short tendinous fibres from the lower edge of the zygomatic arch, and is inserted into the rough surface upon the outer aspect of the angle of the lower jaw. The superficial fibres (15) are directed downward and slightly backward, but the deep-seated (16) are nearly vertical, as may be readily seen by dissecting off the former.

RELATIONS.—It is overlapped by the parotid gland, orbicular muscle of the eye, and great zygomatic, and is crossed transversely by the duct of the parotid gland (duct of Steno), the transverse artery of the face, and the branches of the facial nerve.

ACTION.—The superficial portion of the muscle elevates the lower jaw, and throws it somewhat forward; the deep-seated draws it directly upward, and when the muscle of only one side is brought into action, the jaw is carried slightly to the corresponding side, producing a kind of grinding motion.

DISSECTION.—Remove the skin from the side of the head above the zygoma, and the temporal aponeurosis will be brought into view.

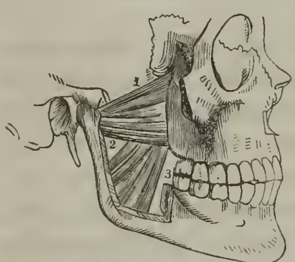
The *temporal aponeurosis or fascia* (Fig. 203, 20) is a dense, strong, fibrous membrane, covering in the temporal muscle, and attached above to the semicircular ridge upon the side of the cranium, and below, to the superior margin of the zygomatic arch and malar bone. In the latter situation it consists of two laminæ, inclosing a small quantity of adipose tissue, and a few bloodvessels. It is overlapped above by the tendinous expansion of the occipito-frontal muscle, crossed by the superficial temporal vessels and nerves, and has rest-

ing upon it the elevator (19) and retractor (17) muscles of the auricular cartilage. Its internal surface is in contact with the muscle, and gives origin above to many of its fibres.

Dissection.—Cut away the aponeurosis and detach the superior extremity of the masseter, and the temporal muscle will be almost entirely brought into view; in order properly to expose its lower portion, the zygoma must be removed.

The temporal muscle, large, flat, and fan-shaped, arises from the under surface of the temporal aponeurosis, from the semicircular ridge on the temporal and frontal bones, and from the whole surface of the temporal fossa. From these points the fibres converge downward to form a thick fleshy mass, which, passing beneath the zygomatic arch, is inserted by strong tendinous fibres into the two surfaces and edges of the coronoid process of the lower jaw. It is covered by the temporal fascia, zygoma, and upper extremity of the masseter muscle; internally, it is in relation with the temporal fossa, external pterygoid muscle, internal maxillary artery, and deep temporal vessels.

Fig. 204.



The two pterygoid muscles. The zygomatic arch and the greater part of the ramus of the lower jaw have been removed, in order to bring these muscles into view. 1. The sphenoid origin of the external pterygoid muscle. 2. Its pterygoid origin. 3. The internal pterygoid muscle.

Action.—Simply to elevate the lower jaw.

Dissection.—Remove the temporal and masseter muscles, and saw out the zygoma, coronoid process, and anterior two-thirds of the ramus of the lower jaw, and a view of the two pterygoid muscles, like that represented in the above figure, will be obtained.

The internal pterygoid muscle is thick and irregularly triangular, and situated deep in the zygomatic fossa along the inner face of the ramus of the jaw. It arises from the inner side of the external pterygoid plate, pterygoid fossa, and pyramidal portion of the palate bone, descends obliquely backward and outward, and is inserted into the inner face of the angle of the lower jaw, and the rough surface immediately above. It is in relation *internally* with the tensor muscle of the palate and with the pharynx, a quantity of cellulo-adipose tissue intervening; and *externally* with the ramus of the jaw, from which it is partly separated by the dental and lingual nerves, inferior dental

vessels, and internal lateral ligament of the temporo-maxillary articulation.

Use.—To elevate the lower jaw, and, the muscle of only one side acting, to carry it toward the opposite side, producing a true grinding motion.

The EXTERNAL PTERYGOID MUSCLE is smaller and shorter than the preceding, and irregularly conoidal in shape. It originates by its larger extremity from the outer face of the external pterygoid plate, from the ridge that separates the zygomatic and temporal fossa, and from the tuberosity of the superior maxilla; from these points the fibres converge outward and backward, and are inserted into the anterior and internal parts of the neck of the lower jaw, and into the interarticular cartilage of the temporo-maxillary joint, and its inferior synovial membrane. It is in relation, externally, with the ramus of the jaw, temporal muscle, and internal maxillary artery; internally, with the internal pterygoid muscle.

Use.—To carry the jaw forward, and, one muscle acting toward the opposite side, to keep the interarticular cartilage upon the surface of the condyle, and to draw the loose synovial membrane from between the two that it may not be pinched.

VESSELS AND NERVES OF THE FACE.

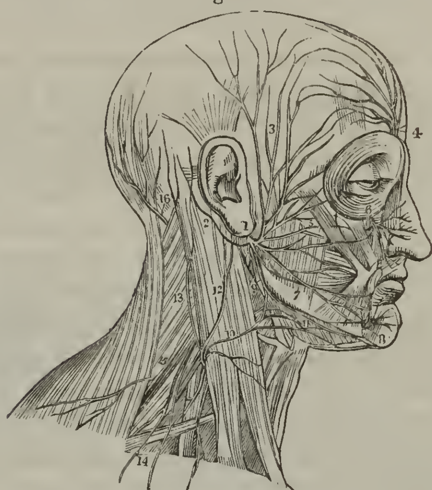
The NERVES of the exterior of the face are branches of the facial, and the fifth or trigeminal. The former make their appearance from behind the masseter muscle just below the ear, and the latter from the supra-orbital, infra-orbital, and sub-mental foramina. A previous examination of Fig. 205, showing their position, will aid the student in making the proper dissections.

Dissection.—The skin should be carefully removed, as it was upon the other side, and the main branches of the nerves sought for and traced to their small subdivisions, taking care at the same time not to cut away the larger bloodvessels.

The FACIAL NERVE (Fig. 205) leaves the cranial cavity through the internal auditory foramen, and, emerging at the stylo-mastoid foramen, bends forward over the external carotid artery, and passes through the parotid gland to the side of the face. Before reaching the latter situation it gives off quite a number of important branches, which need not be mentioned here, and in the substance of the

parotid divides into two main portions, a superior, or temporo-facial, and an inferior, or cervico-facial. The *temporo-facial*, the larger of the two, arches upward and forward, and divides into three sets of

Fig. 205.



The distribution of the facial nerve and the branches of the cervical plexus. 1. The facial nerve, escaping from the stylo-mastoid foramen. and crossing the ramus of the lower jaw; the parotid gland has been removed in order to see the nerve more distinctly. 2. The posterior auricular branch; the digastric and stylo-mastoid filaments are seen near the origin of this branch. 3. Temporal branches, communicating with (4) the branches of the frontal nerve. 5. Facial branches, communicating with (6) the infra-orbital nerve. 7. Facial branches, communicating with (8) the mental nerve. 9. Cervico-facial branches, communicating with (10) the superficial cervical nerve, and forming a plexus (11) over the submaxillary gland. The distribution of the branches of the facial in a radiated direction over the side of the face, and their looped communications, constitute the pes anserinus. 12. The large auricular nerve, one of the ascending branches of the cervical plexus. 13. The small occipital, ascending along the posterior border of the sterno-mastoid muscle. 14. The superficial and deep-descending branches of the cervical plexus. 15. The spinal accessory nerve, giving off a branch to the external surface of the trapezius muscle. 16. The large occipital nerve, the posterior branch of the second cervical nerve.

branches; one set crosses over the zygomatic arch to be distributed to the temporal and occipito-frontal muscles; another spreads out upon the forehead, supplying the corrugator and parts of the orbicular and occipito-frontal muscles; and a third, formed by the subdivision of one or two considerable branches that cross the masseter muscle in company with the duct of Stenon, is distributed to the lower half of the orbicular muscle of the eye, the muscles of the nose, and of the upper lip, forming a beautiful plexus with the infra-orbital branches of the fifth pair. The *cervico-facial* divides into three or four branches just as it leaves the parotid gland, which, crossing the lower part of the masseter muscle, are distributed to the muscles of

the lower part of the face, a few filaments (cervical branches) descending to the upper part of the neck.

The branches of the FIFTH OR TRIFACIAL NERVE are the supra-orbital, infra-orbital, and mental, and should be sought for where they emerge from their respective foramina (Fig. 205), and carefully dissected to their small subdivisions. The *supra-orbital*, or *frontal nerve* (4), derived from the first branch of the fifth, is double, one main trunk traversing the supra-orbital notch, and the other passing over the margin of the orbit near its middle. From these two trunks branches are distributed to the upper eyelid, and to the skin and periosteum of the forehead and top of the head. The *infra-orbital* (6) is the terminal branch of the second, or superior maxillary division of the fifth. It emerges at the infra-orbital foramen, and immediately expands into a great number of filaments, a few of which ascend to the skin and mucous membrane of the lower eyelid, but most of them descend divergingly to the skin of the side of the nose and upper lip, forming a beautiful plexus with the branches of the facial. The *mental nerve* (8) is derived from the inferior dental, which is one of the main divisions of the inferior maxillary, or third branch of the fifth pair. It makes its appearance at the mental foramen, and immediately divides into diverging filaments that are distributed to the skin and mucous membrane of the lower lip.

The ARTERIES that supply the superficial parts of the face and side of the head are the temporal, facial, supra-orbital, infra-orbital, and mental.

The TEMPORAL ARTERY (Fig. 208, 24) is one of the terminal divisions of the external carotid, and is a vessel of considerable size. Commencing in the substance of the parotid gland, it ascends over the posterior root of the zygoma, about an inch and a half or two inches above which it divides into the anterior and posterior temporal branches. In the first part of its course it is deeply seated behind the condyle of the lower jaw, but, ascending over the root of the zygoma, it becomes subcutaneous, and here its pulsations may be felt and the vessel readily compressed. In the substance of the gland it gives off several small branches to the external ear (auricular branches); and one, called the *transverse facial* (Fig. 208, 23), crosses the masseter muscle in company with the Stenonian duct from the parotid gland, and sends twigs to the gland, muscle,

and superjacent skin. Just above the zygoma it sends off the *middle*, or *deep temporal* (25), which perforates the temporal aponeurosis and muscle to gain the superficial groove upon the squamous portion of the temporal bone, along which it divides into smaller twigs for the muscle and neighboring periosteum. Another branch (orbital) is also sometimes given off, near this same point, to the parts about the eyebrow. The *anterior temporal* (Fig. 208, 34), the smaller of the two terminal divisions, ascends forward beneath the skin to the forehead, whence it bends backward to the top of the head, supplying all the adjacent parts, especially the scalp and periosteum. It is this vessel that is sometimes divided for the abstraction of blood. The largest of the branches of the anterior temporal is sometimes called the *middle temporal* (Fig. 208, 35). The *posterior temporal* (Fig. 208, 36) passes tortuously upward and backward between the skin and temporal aponeurosis, and literally covers the side and top of the head with its ramifications. So freely do these two vessels anastomose with each other, with their opposite fellows, and with the supra-orbital and occipital arteries, that when cut by accident or otherwise, and it becomes necessary to use the ligature, both of the cut ends have often to be secured before the bleeding can be arrested.

The FACIAL ARTERY, or EXTERNAL MAXILLARY, also a branch of the external carotid, makes its appearance upon the face over the base of the lower jaw, just at the anterior inferior corner of the masseter muscle. From this point it ascends obliquely, in a remarkably tortuous manner, toward the inner angle of the eye, sending off branches to the lips, side of the nose, buccinator, masseter, and orbicular muscles, and to the superjacent skin. The two branches to the lips are denominated the *superior* and *inferior coronary*, or *labial* (8, 9); they are the largest of the divisions, and ramify in a zigzag manner, anastomosing freely with their opposite fellows. The superior furnishes a branch to the septum of the nose. Arrived near the inner canthus of the eye, the main trunk of the artery, very much reduced in size, terminates by anastomosing with the infra and supra-orbital arteries.

Accompanying the facial artery is the *facial vein*, which, following the same course in an opposite direction, terminates in the internal jugular, as will be seen hereafter.

The SUPRA-ORBITAL ARTERY, the last division of the ophthalmic,*

* A branch of the internal carotid.

is not a vessel of any great size. It emerges at the supra-orbital notch, and immediately divides into a great number of twigs, that are distributed to the eyelid, orbicular, and occipito-frontal muscles, anastomosing with the anterior temporal. The *infra-orbital*, a branch of the internal maxillary,* and, like the preceding, of small size, makes its appearance at the infra-orbital foramen, having traversed the groove and canal in company with the nerve of the same name, and divides into numerous small palpebral, muscular, periosteal, alveolar, and cutaneous twigs, which anastomose with the facial and transverse arteries upon the front of the upper jaw.

The deep parts of the face are supplied by the *internal maxillary artery*, which, however, is more conveniently dissected in connection with the cervical branches of the external carotid.

THE NECK.

One side of the neck should be dissected with special reference to the muscles, and the other to the vessels and nerves.

MUSCLES OF THE NECK.

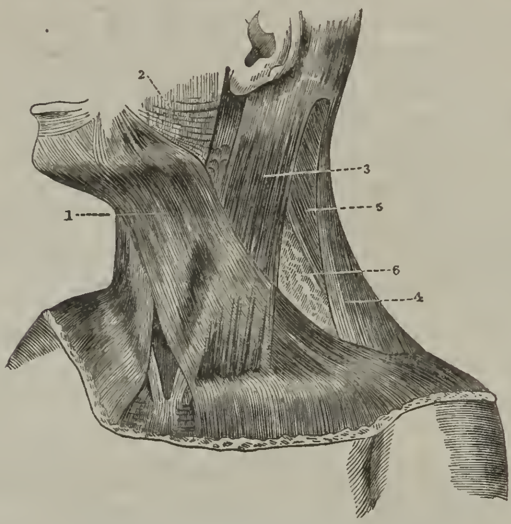
Dissection.—For this dissection the left side of the neck is preferable to the right, and in order to place the subject in the most convenient position, draw the head to the end of the table, place a block under the shoulders, so as to put the neck on the stretch, turn the face a little to the right side, and fasten it in this position by means of hooks. Next, carry an incision along the median line, from the under part of the chin to the top of the sternum; another from the latter point along the anterior margin of the clavicle to within an inch or two of the acromion; and a third (if this has not already been made in the dissection of the face) along the base of the lower jaw, and immediately beneath the ear to the mastoid process of the temporal bone. This done, let the student examine the annexed figure in order to ascertain the position of the first muscle to be encountered, namely, the platysma; and then, placing himself at the end of the table, commence at the lower anterior angle of the flap, and turn it entirely back, carrying the cutting edge of the scalpel close to the under surface of the skin, and in the direction of the fibres of the above-mentioned muscle. If the dissection is very close, a thin fascia will be left upon the surface of the muscle, but in general it is better to remove this along with the skin.

The PLATYSMA MUSCLE (*platysma myöides*, Fig. 206), the only strictly cutaneous muscle in the human body, is a large, thin, quad-

* One of the terminal divisions of the external carotid.

rangular layer of pale fleshy fibres, situated obliquely upon the side of the neck, and extending from over the shoulder and upper part of the

Fig. 206.



1. Platysma muscle. 2. Scattered fibres of the same, forming the laughing muscle of Santorinus. 3. Sterno-cleido-mastoid. 4. Trapezius. 5. Splenius. 6. Posterior large triangle of the neck, bounded in front by the sterno-cleido-mastoid, behind by the trapezius, and below by the clavicle.

thorax to the lower anterior part of the face. Its lower extremity, commonly called its origin, is blended with the subcutaneous areolar tissue. Above, it is generally disposed as follows: The *anterior fibres* intersect those of the opposite side, just below the chin, the *middle* have an imperfect attachment to the lower jaw, and the *posterior* are continued upon the face in front of the ear, and thence to the angle of the mouth, constituting what was formerly called the *laughing muscle of Santorinus.* The platysma is often but poorly developed, but never entirely wanting.

USE.—To wrinkle the skin of the neck, to assist very slightly in depressing the lower jaw, and by its posterior fibres to draw the angle of the mouth outward and upward.

DISSECTION.—Divide the platysma along the clavicle and turn it upward, taking care not to disturb the subjacent fascia.

The *superficial layer of the cervical fascia* covers the whole of the anterior and lateral regions of the neck, extending from the lower jaw and mastoid process above, to the sternum and clavicle below,

and from the median line in front, where it forms a kind of raphé to the nape of the neck behind. Superiorly, and more especially behind the angle of the jaw, it is very thick and strong, and in this situation deserves rather to be called an aponeurosis. It unites with the deep layer to form sheaths for the several subjacent cervical muscles, and from the lower part of the neck may be traced over the clavicle to become continuous with the superficial fascia of the thorax.

Dissection.—Commence at the median line and turn the superficial fascia back in one continuous layer, so as to expose the sterno-hyoid and sterno-mastoid muscles. In doing this a small vein, called the *external jugular*, will be observed extending from beneath the angle of the lower jaw to the lower part of the neck, behind the middle of the clavicle, crossing the sterno-mastoid muscle. The ascending cervical nerves will also be seen upon the surface of the muscle above; but as they will be more particularly noticed in the dissection of the other side of the neck, they may be here removed with the fascia.

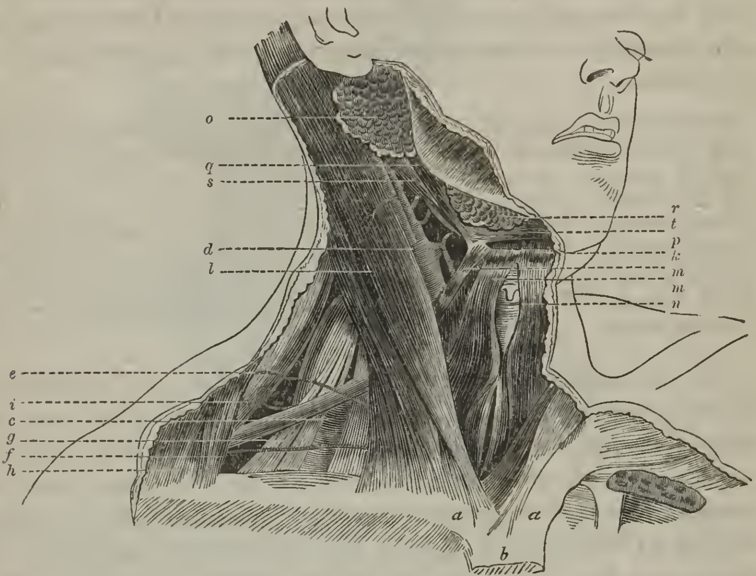
The sterno-cleido-mastoid muscle* (Fig. 207), the longest and largest muscle of the anterior and lateral cervical regions, extends obliquely across the neck from below and in front, upward and backward, to the side of the head behind the ear. It arises from the anterior edge of the upper extremity of the sternum, where it almost touches its fellow of the opposite side, and from the upper edge of the sternal third of the clavicle, and is inserted into the outer surface of the mastoid process of the temporal bone and the adjacent third of the superior semicircular line of the occiput. Its lower extremity or origin consists of a separate clavicular and a sternal head or slip, the former composed of fleshy and tendinous fibres spread along the clavicle to a variable extent, and the latter of a well-defined flat tendon. The two divisions ascend, the clavicular portion almost vertically, and the sternal obliquely backward, and unite generally about two or three inches above their origin, but they not unfrequently remain separate for a much longer distance, although lying side by side, and held together by areolar tissue. The variable extent to which the clavicular portion is attached along the clavicle in different individuals, occupying, as it sometimes does, nearly one-half, and in others not more than one-fourth of the length of the bone, is a fact of no little interest in reference to the operation of ligating the subclavian artery.

Relations.—The sterno-mastoid is covered by the superficial

* Sometimes called, for the sake of abbreviation, "sterno-mastoid."

layer of the cervical fascia, which, as before mentioned, is exceedingly dense and firm above; it is crossed by the external jugular vein, and by the ascending branches of the cervical plexus of nerves

Fig. 207.



Lateral view of the neck with the skin, platysma, and cervical fascia removed. *a, a.* Sternal ends of the clavicles. *b.* Upper part of the sternum. *c.* Third portion of the subclavian artery. *d.* Primitive carotid artery dividing into the internal and external carotids. *e.* Posterior scapular artery. *f.* Transverse cervical or supra-scapular artery. *g.* Brachial plexus of nerves. *h.* Trapezius muscle. *i.* Tendon of the omo-hyoid muscle. *k.* Anterior belly of omo-hyoid. *l.* Sterno-cleido-mastoid muscle. *m, m.* Sterno-hyoid muscles. *n.* Larynx. *o.* Parotid gland. *p.* Submaxillary gland. *q.* Posterior belly of the digastric muscle. *r.* Anterior belly of the same. *s.* Stylo-hyoid muscle. *t.* Hyoid bone.

and platysma muscle. Its deep relations are numerous, and will be hereafter mentioned.

Action.—To incline the head to the corresponding side, and rotate it so that the face will be turned in an opposite direction. Both muscles acting simultaneously flex the head forward, unless it has been already thrown far back, when their tendency is to increase this posterior flexion, as is seen in opisthotonos.

Dissection.—Cut the preceding muscle from the inferior attachment, and turn it upward; in doing this, the spinal accessory nerve will be seen perforating its posterior border above and descending towards the shoulder.

The *deep layer of the cervical fascia*, now almost entirely exposed, stretches across the whole breadth of the neck, and is attached above

to the base of the lower jaw and below to the posterior surface of the clavicle and upper extremity of the sternum. Besides forming the posterior layer of the sheath of the sterno-cleido-mastoid muscle, it sends processes around nearly all of the subjacent vessels, nerves, and muscles, forming so many separate envelops or sheaths to these several structures. One of the most important of these processes extends from the angle of the lower jaw to the styloid process; it is called the *stylo-maxillary ligament*, and forms a strong septum between the parotid and submaxillary glands.

The unyielding nature and close attachment of this membrane to the clavicle, spine, and lower jaw, explain the tendency that deep-seated fluid, and even solid tumors in this situation manifest, to spread into the surrounding regions,* and the difficulties that so commonly attend their diagnosis.

DISSECTION.—Reverse the cervical fascia from all of the subjacent parts, first in the lower and afterward in the upper part of the neck. The student should be here reminded that, unless he is willing to give sufficient time and patience to the entire removal of all the fat and cellular tissue that conceals the subjacent parts, he had better quit dissecting and turn his attention to something else; for if there is any region of the body whatever, that more than another amply repays one for the care and labor that is required for its display, this is that part.

The muscles exposed by this dissection in the lower and anterior parts of the neck are the sterno-hyoid, sterno-thyroid, thyro-hyoid, crico-thyroid, omo-hyoid, and anterior scalenus.

The STERNO-HYOID MUSCLE, long and ribbon-like, arises from the posterior surface of the upper part of the sternum and cartilage of the first rib, ascends a little obliquely, in front of the neck, and is inserted into the lower border of the hyoid bone near its middle.

USE.—To depress the hyoid bone, and with it the root of the tongue.

RELATIONS.—It is covered by the superficial cervical fascia, crossed obliquely below by the sterno-cleido-mastoid, and lies upon the sterno-thyroid and thyro-hyoid muscles, and thyroid gland.

DISSECTION.—Cut the sterno-hyoid across its middle, reflect back its two ends, and dissect the cervical fascia from the two subjacent muscles.

* In many instances have deep-seated abscesses in this situation been known to extend downward into the chest, and their true nature not ascertained until after death.

The STERNO-THYROID MUSCLE, broader and shorter than the preceding, arises from the posterior surface of the upper part of the sternum and cartilage of the first rib, ascends directly upward, and is inserted into the oblique ridge upon the outer surface of the thyroid cartilage.

USE.—To depress the larynx.

RELATIONS.—It is almost entirely covered by the preceding muscle, projecting, however, beyond its outer edge. It lies directly in front of the junction of the subclavian and internal jugular veins, the trachea and thyroid gland, overlapping by its outer edge the common carotid artery, and is in contact with the internal jugular vein.

The THYRO-HYOID MUSCLE, small and quadrangular, and apparently a continuation of the preceding, arises from the oblique ridge upon the thyroid cartilage, and is inserted into the posterior surface of the body and adjacent part of the greater horn of the hyoid bone.

USE.—To approximate the thyroid cartilage and hyoid bone.

RELATIONS.—It is covered by the sterno-hyoid muscle, and rests upon the thyroid cartilage and thyro-hyoid membrane.

The OMO-HYOID MUSCLE, long and slender, arises broad and fleshy from the ligament of the scapular notch and the margin of the bone immediately behind, and is inserted into the hyoid bone just outside of the insertion of the sterno-hyoid. It consists of two fleshy bellies and an intermediate tendon. The lower belly is somewhat rounded, and passes from its origin almost transversely, but inclining a little upward, across the lower part of the neck almost as far as the trachea; here a small rounded tendon is formed, inclosed by a fold or loop of the cervical fascia, beyond which the muscle becomes again fleshy and turns almost directly upward, inclining toward the median line to its insertion. The loop through which the tendon of the muscle passes is attached below to the clavicle, and acts as a pulley, the effect of which is to alter the direction of the muscle, making its line of action downward and very little backward from the hyoid bone.

RELATIONS.—Its origin from the scapula is concealed by the trapezius muscle and clavicle, and above the latter the lower belly is covered only by the cervical fascia, a few lymphatic glands, the platysma muscle, and the skin; above this point it is almost entirely

hid by the sterno-cleido-mastoid. It crosses from behind the brachial plexus of nerves, anterior scalene muscle, phrenic nerve, the branches of the thyroid artery, internal jugular vein, common carotid artery, and pneumogastric nerve. This muscle is one of the guides to the operation for tying the subclavian artery, which vessel is situated immediately below and internal to the inferior fleshy belly.

The ANTERIOR SCALENE MUSCLE (*scalenus anticus*), although belonging to an entirely different group, is best seen in this dissection, and should be particularly noticed on account of its relation to the subclavian artery. It is situated deeply behind the middle of the clavicle, and is somewhat conoidal in shape, with its base presenting downward; it arises tendinous from the eminence upon the middle of the upper surface of the first rib, ascends a little backward, and is inserted into the anterior tubercles of the transverse processes of the lower four cervical vertebræ.

USE.—To elevate the anterior part of the thorax, aiding thus in inspiration; or, the thorax being the fixed point, to assist in bending the neck forward and a little to the same side.

RELATIONS.—It is crossed in front, below, by the subclavian vein; near the middle, by the transverse and supra-scapular arteries; and obliquely, from above downward and inward, by the phrenic or diaphragmatic nerve. Its posterior surface is covered below by the pleura (the serous lining of the thorax), crossed about the middle by the subclavian artery, and rests above upon the large nerves that here leave the spine to form the brachial plexus. Its inner border is nearly in contact with the thyroid axis and its branches, and separated by a very narrow interval from the vertebral artery. With the lower belly of the omo-hyoid muscle externally and the first rib below, its outer border forms a triangular space, through which the subclavian artery and brachial plexus of nerves pass on their way to the axilla. It is in this space that the artery is usually sought for to be ligatured.

DISSECTION.—Remove the whole of the sterno-mastoid, hyoid, and thyroid, and omo-hyoid muscles, leaving the scalene in its place; and proceed to the study of the upper part of the neck. The structures that will first claim attention here, are the parotid and submaxillary salivary glands. To expose the former, that very dense portion of the cervical fascia already mentioned as existing behind the angle of the lower jaw, must be dissected off; the latter is seen beneath the base of the lower jaw, upon the removal of the platysma muscle and subjacent thin layer of fascia.

THE PAROTID AND SUBMAXILLARY GLANDS.

The *parotid gland* (Fig. 207), the largest of the three salivary glands, occupies a tolerably large irregular cavity, with the shape of which it nearly corresponds. The cavity is bounded in front by the ramus of the lower jaw and stylo-maxillary ligament; behind, by the external ear, mastoid process, and upper extremity of the sterno-cleido-mastoid muscle; above, by the zygoma and back part of the glenoid cavity; internally, by the styloid process, and below, by the digastric and stylo-hyoid muscles. The deep part of the organ is narrow and irregularly contracted; but externally, it is expanded over the adjacent borders of the masseter and sterno-mastoid muscles. It belongs to the class of racemose or vesicular compound glands. Its color is pale pink, its appearance very rough and ragged, and it consists of numerous lobes and almost innumerable smaller lobules, held together by ducts, bloodvessels, and interlobular areolar tissue continuous with the dense fascia that invests its external surface. By the union of the several minute ducts belonging to the individual lobules one main trunk is formed, about the size of a crow-quill, and named the *duct of Stenon.* The duct proceeding forward from the body of the gland, just below the zygoma, crosses the masseter muscle, perforates the buccinator, and, continuing a short distance between the latter and the mucous membrane, opens upon the inner surface of the cheek opposite the first or second upper molar tooth. Connected with the duct and resting upon the outer surface of the masseter muscle, is often found a small portion of the gland detached, as it were, from the main body. The parotid gland is perforated by the external carotid, temporal, internal maxillary, and transverse facial arteries, temporal and internal maxillary veins, and facial nerve. From these vessels the proper arteries and veins of the gland are derived. This gland is sometimes the seat of disease that demands surgical interference. The difficulties attending its entire removal (and numerous such feats are recorded) may be in some degree appreciated by the student, by here attempting it himself, and he will find that he has no easy task to perform; but the greater difficulties in the living subject, increased by the gush of blood and the diseased condition of the parts, he need not desire to encounter.

The SUBMAXILLARY GLAND, the second of the salivary glands, in

point of size, is situated beneath the middle of the body of the lower jaw, and rests upon the milo-hyoid muscle, hypoglossal nerve, and the tendon of the digastric muscle. It is covered in by the cervical fascia and platysma muscle, and separated from the parotid gland by the strong inversion of the cervical fascia, called the stylo-maxillary ligament. It is of a pale pink color, oblong in shape, of an irregular surface, and grooved internally for the passage of the facial artery. Like the parotid, it is composed of lobes and smaller lobules held together by vessels, nerves, and an interlobular areolar tissue, continuous with a thin, imperfect, areolar investment derived from the cervical fascia. The excretory duct, called also Wharton's duct, formed by the union of the smaller ducts from the elementary lobules, leaves the deep part of the gland, winds around the posterior margin of the milo-hyoid muscle, passes along the inner side of the sublingual gland, and opens into the cavity of the mouth by a very small orifice upon the summit of a little papilla, situated by the side of the frænum of the tongue. The walls of this duct are very thin, which renders it somewhat difficult to find, but its caliber is nearly as great as that of the parotid duct. The arteries of the gland are derived from the facial, that passes along a groove upon its surface.

Dissection.—Remove the submaxillary gland, make the subjacent muscles tense by means of a hook extending from over the body of the hyoid bone to the chest, and dissect off the cervical fascia.

The muscles composing the supra-hyoid group are the digastric, stylo-hyoid, milo-hyoid, genio-hyoid, hyo-glossal, genio-hyo-glossal, stylo-glossal, and lingual.

The digastric muscle (Fig. 207) consists of two conoidal fleshy bellies, and an intervening rounded tendon. It arises from a groove upon the inner side of the base of the mastoid process of the temporal bone, descends forward toward the hyoid bone, near which its tendon passes through a loop of the cervical fascia and the fleshy part of the stylo-hyoid muscle; it then ascends obliquely to be inserted into a rough depression upon the inner side of the base of the lower jaw, close to the symphysis.

Use.—To elevate the hyoid bone and the parts connected with it, or to depress the lower jaw.

Relations.—Its anterior belly is covered only by the cervical fascia, platysma, and skin; but its posterior is rather deeply situated beneath the parotid gland and the insertion of the sterno-cleido-mastoid muscle. By its angular course, it forms with the base of

the lower jaw, a triangular space in which the submaxillary and parotid glands are contained, separated from each other by the stylo-maxillary ligament.

DISSECTION.—Detach the posterior belly of the digastric, and turn it forward.

The STYLO-HYOID MUSCLE, very slender, arises by a small tendon from the styloid process of the temporal bone, descends forward, and is inserted fleshy into the body of the hyoid bone. It is perforated near its insertion by the tendon of the digastric.

USE.—To elevate the hyoid bone and its connections, carrying them at the same time backward toward the spine.

DISSECTION.—Detach the anterior belly of the digastric, and turn it downward.

The MILO-HYOID MUSCLE, flat and triangular, forms the inner wall or floor of the digastric triangle or fossa. It originates from the whole length of the milo-hyoid ridge of the inferior maxilla, from which its fibres descend forward, the posterior and longer to be inserted into the body of the hyoid bone, and the anterior into the corresponding muscle of the opposite side, forming with it a median raphé or line of intersection, extending from the symphysis of the chin to the middle of the hyoid bone.

USE.—To elevate the hyoid bone and larynx; or, this bone being the fixed point, to depress the lower jaw.

RELATIONS.—Externally, it is in relation with the submaxillary gland and anterior belly of the digastric; internally, with the hypoglossal, and gustatory nerves, and Whartonian duct, which separate it from the hyo-glossal muscle, with the sublingual gland, mucous membrane of the mouth, and genio-hyoid muscle.

DISSECTION.—Detach the milo-hyoid from the lower jaw and hyoid bone, reflect it forward, and separate it from its opposite fellow.

The GENIO-HYOID MUSCLE, small and rounded, extends from the tubercle upon the posterior aspect of the symphysis of the lower jaw to the body of the hyoid bone. It is closely connected to its fellow of the opposite side, the anterior border of the hyo-glossal muscle, and the posterior surface of the anterior portion of the milo-hyoid.

USE.—To elevate the hyoid bone, or depress the lower jaw.

DISSECTION.—Dissect the genio-hyoid from its connections, and remove it from the body.

The HYO-GLOSSAL MUSCLE, flat and quadrangular, arises from the body and greater horn of the hyoid bone, and is inserted into the side of the under surface of the tongue near its margin.

USE.—To depress the tongue, or draw it back when protruded, and to elevate the hyoid bone.

RELATIONS.—By its outer surface with the gustatory and hypoglossal nerves and duct of Wharton, which separate it from the milo-hyoid; with the submaxillary and sublingual glands and stylohyoid muscle; by its deep surface, with the middle pharyngeal constrictor and genio-hyo-glossal muscles, the lingual artery lying between it and the latter.

DISSECTION.—Detach the hyo-glossal entirely, and draw the hyoid bone downward as far as possible.

The GENIO-HYO-GLOSSAL MUSCLE, broad and fan-shaped, arises from the tubercle upon the back part of the symphysis of the lower jaw, from which its fibres diverge in an antero-posterior direction to be inserted into the whole length of the under surface of the tongue, the most anterior and inferior curving downward to be attached to the body of the hyoid bone.

USE.—Its anterior and middle fibres elevate the hyoid bone, or protrude the tongue, according as the jaw or hyoid bone is the fixed point; the anterior and superior withdraw this organ when protruded.

RELATIONS.—By its outer surface with the preceding muscle, lingual artery, and sub-lingual gland; internally, with its fellow of the opposite side; and by its anterior margin, with the genio-hyoid muscle.

The LINGUAL MUSCLE (*lingualis*) is a bundle of fleshy fibres, placed upon the inferior surface of the tongue, just outside of the insertion of the preceding, extending the whole length of the organ, from base to apex, without any bony attachment.

USE.—To shorten the tongue, and bend its apex downward, or to one side.

The STYLO-GLOSSAL MUSCLE, small and slender, arises from near the extremity of the styloid process, passes forward and a little downward, spreads out, and is inserted into the side of the under surface of the tongue nearly as far as its tip, its fibres blending with those of the hyo-glossal.

Use.—To draw the tongue backward and to one side.

Relations.—It is covered externally by the parotid gland, internal pterygoid muscle, gustatory nerve, mucous membrane, and sublingual gland; internally, it is in apposition with the stylo-hyoid ligament, tonsil, and superior constrictor muscle of the pharynx.

The stylo-pharyngeal muscle, deeper seated than the preceding, but also seen in this dissection, is long and slender. It arises from the base of the styloid process, descends forward, spreads out, and is inserted into the side of the pharynx, some of its fibres reaching as far as the hyoid bone and thyroid cartilage.

Use.—To elevate and dilate the pharynx.

Relations.—It is covered by the stylo-hyoid and other muscles of this group, the external carotid artery, and parotid gland; internally, it is in contact with the internal carotid artery, jugular vein, sympathetic and pneumogastric nerves. The glosso-pharyngeal nerve passes along its outer border.

This completes the muscles of the side of the neck; but, before leaving this region, the student should examine the sub-lingual gland, which is already exposed by the removal of the milo-hyoid muscle.

The sub-lingual gland, the smallest of the three salivary glands, is of an oval or oblong figure, and about the size of a white bean. It is situated beneath the mucous membrane of the mouth, by the side of the bridle of the tongue, resting upon the anterior part of the mylo-hyoid muscle. Its anterior extremity is very nearly in contact with its fellow of the opposite side, and along its inner border, and in close apposition passes the duct of the sub-maxillary gland.

Its structure is precisely similar to that of the parotid and submaxillary, but instead of having only one excretory duct, it has eight or ten, which open upon the floor of the mouth, by the side of the bridle of the tongue.

The student should now turn to the other (right) side of the neck, to study more particularly the vessels and nerves.

VESSELS AND NERVES OF THE NECK.

For this dissection, it is supposed that the student has reserved the right side of the neck, although an examination of both sides is

to a certain extent necessary, owing to differences in the carotid and subclavian arteries presently to be mentioned.

Dissection.—The left side of the neck and both sides of the face having been already dissected, only one incision becomes necessary, namely, from the sternum along the clavicle, to within a short distance of the acromion. The skin and platysma muscle may be here removed together, care being taken to leave the external jugular vein. Next, dissect the superficial layer of the cervical fascia from the sterno-cleido-mastoid muscle, without disturbing the ascending and descending branches of the cervical plexus of nerves represented in Fig. 205, 10, 12, 14.

The external jugular vein (Fig. 210), situated upon the side of the neck, is superficial to the cervical fascia and sterno-cleido-mastoid muscle, and corresponds to a line drawn from the angle of the jaw to the middle of the clavicle. It is exceedingly variable in size, but generally small; is usually formed by the union of the temporal and internal maxillary veins, and receives in its course the superficial occipital, supra and posterior scapular veins, and sometimes the facial, lingual, and superior laryngeal. At its superior extremity it communicates with the internal jugular, and terminates below in the subclavian vein by perforating the cervical fascia.

Relations.—It crosses the sterno-cleido-mastoid and omo-hyoid muscles obliquely, and is covered by the skin and platysma, the fibres of the latter crossing it obliquely from above downward and backward.

Bleeding from this vein, an operation oftener described than practised, at least, in this country, is performed by making an incision across the direction of the fibres of the platysma, in order that by their contraction the sides of the orifice may be drawn asunder, thus promoting the flow of blood, which effect would be rather counteracted if the incision were made in an opposite direction, that is, in a line with the fibres.

The three small nerves seen upon the surface of the sterno-mastoid muscle, in the neighborhood of the external jugular vein (Fig. 205), are branches of the cervical plexus. One of them, called the *superficial cervical* (10), makes its appearance behind the posterior margin of the muscle near its middle, ascends obliquely across its surface toward the lower jaw, beneath which it forms a plexus with branches of the facial, and is ultimately distributed to the integument in front of the neck. Another, the *large auricular* (12), passes from the same point vertically upward by the side of the external jugular vein, and is distributed to the external ear and the integument immediately below. The third, named the *small occipi-*

tal (13), ascends along the posterior border of the muscle to the skin of the occiput.

From this same plexus may also be seen numerous superficial descending filaments (14), which perforate the cervical fascia just above the clavicle on their way to the integument covering the upper and lateral parts of the chest.

Anterior to the sterno-mastoid muscle, and descending from beneath the lower jaw upon the sheath of the carotid artery and internal jugular vein, is the descending branch of the hypoglossal nerve, called technically the *descendens noni*. Upon the surface of the jugular vein in the lower part of the neck, it forms an anastomotic loop with a branch from the cervical plexus, and sends branches to the sterno-hyoid, and thyroid and omo-hyoid muscles.

Dissection.—Having previously examined the accompanying Figs. 205 and 208, to ascertain the position of the several vessels and nerves to be encountered, flex the neck laterally, so as to relax the sterno-cleido-mastoid, and proceed carefully to dissect all the fascia, and the areolar, and adipose tissues from the subjacent and surrounding parts. In doing this, the lymphatic ganglia or glands of this region are also necessarily removed.

The *lymphatic glands* of the neck, like those in most other parts of the body, are of a pale pink color, oval in shape, and vary in size from that of a large grain of wheat to that of a white bean. They are divided into a superficial and a deep set. The *superficial* group are found, for the most part, upon the surface of the sterno-mastoid muscle, behind this muscle, and above the outer extremity of the clavicle, and in the neighborhood of the parotid and submaxillary glands. A few are also found between the hyoid bone and thyroid cartilage, and upon the sides of the larynx. The *deep* group are more numerous, and form a continuous chain or series along the jugular vein and carotid artery, from the base of the skull to the thorax.

These glands receive the lymphatic vessels from the side of the head and deep parts of the neck, and are remarkable for their proneness to inflammation and tubercular deposit in persons of a strumous diathesis, and more particularly in children.

The arteries of the neck are the carotid and subclavian, and their branches.

The common or primitive carotid artery (Fig. 208, 7) lies deep in the front part of the neck, by the side of the trachea and œsophagus, inclosed in a common sheath with the internal jugular vein and pneumogastric nerve. This sheath, together with the de-

scending branch of the hypoglossal nerve that rests upon its surface, must be removed before the vessels can be distinctly seen. Upon the right side of the neck, the common carotid originates, behind the right sterno-clavicular articulation, from the brachio-cephalic or innominate artery (Fig. 208, 9), which is common to it and the subclavian of the same side; but upon the left it comes directly from the arch of the aorta, just to the left of the origin of the innominate. The left is therefore somewhat longer than the right, but both are nearly of the same size, and are placed upon nearly the same level. From its origin the vessel ascends the neck, gradually inclining outward; it gives off no collateral branches, and, opposite the upper border of the thyroid cartilage, divides into the internal and external carotid (10).

Relations.—The primitive carotid is contained in the same sheath with the internal jugular vein and pneumogastric nerve, the former lying external to the artery, and, when full, overlapping it, and the latter behind and between the two. Its lower half is concealed by the sterno-mastoid, hyoid, and thyroid muscles, the two latter lying directly upon it, and a little higher up it is crossed by the omo-hyoid muscle. Above this point to its bifurcation the vessel is situated in a triangular space formed by the sterno-mastoid, omo-hyoid, and digastric muscles; and, being here covered only by the skin and platysma, is readily found by the surgeon when a ligature is to be applied. Posteriorly, it is separated from the front of the spine by the prevertebral muscles and sympathetic nerve, and is crossed by the inferior thyroid artery (25). Internally, it is in close relation with the trachea (37), œsophagus (38), recurrent laryngeal nerve, larynx, and thyroid gland (39), which last, when enlarged, frequently overlaps it in front.

Variations in the origins of the carotids are rare. The most common is that in which the left comes off from the root of the brachio-cephalic or innominate artery. They have also been occasionally observed to send off collateral branches.

The external carotid artery commences at the bifurcation of the primitive carotid, opposite the upper margin of the thyroid cartilage, and upon the inner side of the internal carotid.* At first, it ascends inward, and then bends backward and a little outward in the

* The terms internal and external, as applied to the carotids, have reference to their distribution; the former supplying the internal, and the latter, the external parts of the head.

direction of the temporo-maxillary articulation, externally to which it terminates by dividing into the temporal and internal maxillary arteries.

Relations.—In the first part of its course, it lies in the triangular space bounded by the sterno-mastoid, omo-hyoid, and digastric muscles, and is covered only by the skin and platysma muscle. A ligature is applied here with some difficulty, owing to the numerous branches that it gives off. About its middle, it lies in close relation with the pharynx; still higher up it is internal to the stylo-hyoid and posterior belly of the digastric muscle, crossed by the hypoglossal nerve, and separated from the internal carotid by the stylo-glossal and stylo-pharyngeal muscles and glosso-pharyngeal nerve. At its termination, it is imbedded in the substance of the parotid gland, and crossed by the facial nerve.

The external carotid has ten branches, including its two terminal ones. They are divided into the

1. *Anterior branches* . . .	the superior thyroid, the lingual, the facial.
2. *Posterior* " . . .	the mastoid, the posterior auricular, the occipital.
3. *Internal* " . . .	the ascending pharyngeal, the internal maxillary, the temporal.

The three anterior branches originate very near each other from the anterior aspect of the artery in the first part of its course, the lingual and facial often by a common trunk.

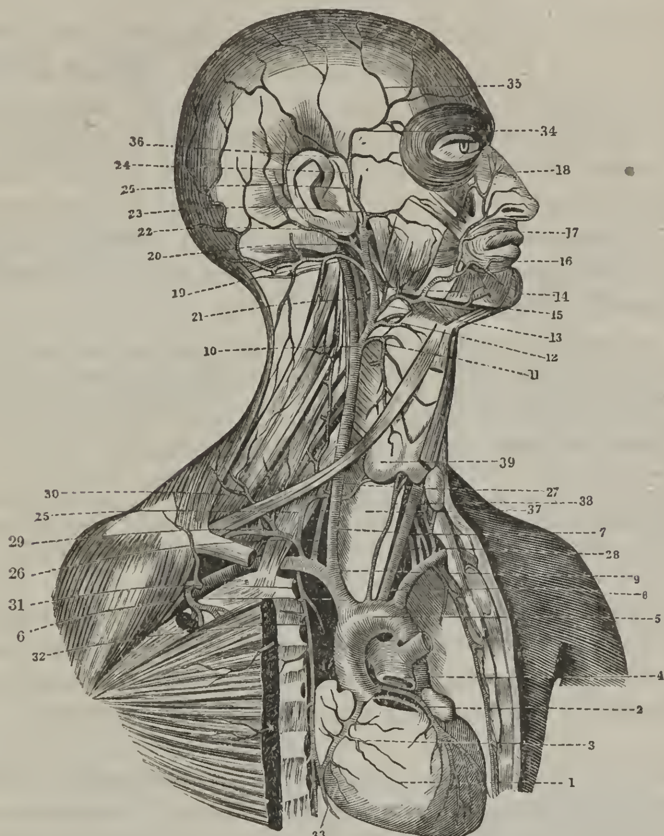
The superior thyroid artery (Fig. 208, 11), a vessel of considerable size, arises from the external carotid, immediately above the bifurcation of the common carotid, descends forward, and is distributed to the thyroid body or gland.

Branches.—In its course, it gives off three small twigs; one, called the *hyoid*, to the sterno-hyoid and thyroid muscles; one, called the *laryngeal*, that perforates the thyro-hyoid membrane in company with the superior laryngeal nerve, to be distributed in the mucous membrane of the larynx; and a third, very small, named the *crico-thyroid*, that passes in front of and below the larynx, sending twigs through the crico-thyroid membrane to the interior of the larynx.

The lingual artery (Fig. 208, 12) originates immediately above the preceding, frequently by a common trunk with the facial, passes

inward above the greater horn of the hyoid bone, then between the hyo-glossal and genio-hyoglossal muscles to the base of the tongue;

Fig. 208.



Arteries of the neck. 1. Heart. 2. Left coronary artery. 3. Right coronary artery. 4. Pulmonary artery cut through. 5. Arch of the aorta. 6. Innominate artery. 7. Right primitive carotid. 8. Left subclavian. 9. Division of the innominate into the right primitive carotid and right subclavian. 10. Division of the primitive carotid into external and internal carotid. 11. Superior thyroid artery. 12. Lingual artery. 13. Facial or external maxillary artery. 14. Inferior palatine artery. 15. Submental artery. 16. Inferior labial artery. 17. Superior labial artery. 18. Lateral nasal branch. 19. Occipital artery. 20. Posterior auricular artery. 21. Ascending pharyngeal artery. 22. Division of the external carotid into temporal and internal maxillary artery. 23. Transverse facial artery. 24. Temporal artery. 25. Middle or deep temporal artery. 25′. Inferior thyroid artery. 26. Vertebral artery. 27. Point at which the vertebral artery enters the opening in the transverse process of the sixth cervical vertebra. 28. Left superior intercostal artery. 29. Transverse cervical artery. 30. Posterior scapular artery. 31. Internal mammary artery. 32. Mediastinal branch. 33. Superior phrenic artery. 34, 35. Anterior temporal artery. 36. Posterior temporal. 37. Trachea. 38. Middle thyroid artery, an anomalous branch of the aorta. 39. Thyroid body. 40. Ascending cervical artery, a branch of the inferior thyroid.

thence, under the name of the *ranine* artery, it runs in a serpentine manner in the substance of the under part of the tongue to its tip.

Branches.—It sends off a *hyoid* twig to the elevator muscles of the larynx, a *dorsal lingual* to the mucous membrane of the superior surface of the tongue, and a *sublingual* to the sublingual gland and adjacent mucous and muscular tissues.

The facial or external maxillary artery (Fig. 208, 13), the largest of the three anterior branches of the external carotid, is given off opposite the hyoid bone. It passes upward and forward beneath the digastric and stylo-hyoid muscles, runs along a groove in the under surface of the submaxillary gland, then turns over the base of the lower jaw just in front of the attachment of the masseter muscle, and ascends in a very tortuous manner toward the internal angle of the eye. Before reaching the latter point, it is diminished by frequent branching to a very small twig.

Branches.—The cervical branches of the facial are: 1. The *inferior palatine*,* very small, which ascends between the stylo-glossal and stylo-pharyngeal muscles, to be distributed to the soft palate and tonsils. 2. The *submaxillary*, four or five in number, given off while the artery is in the groove beneath the submaxillary gland, and distributed to this organ. 3. The *submental*,† that comes off above the preceding, and passes forward upon the surface of the milo-hyoid muscle near its attachment to the lower jaw, to supply the muscles beneath the chin. The facial branches are the labial, or coronary, and angular, which have been already described.

Posterior Branches.—The mastoid artery (represented cut, in Fig. 208) arises from the external carotid nearly opposite the lingual, descends obliquely backward, and is distributed to the sterno-mastoid muscle. It is very small and often wanting.

The occipital artery (Fig. 208, 19) arises a short distance above the preceding, ascends obliquely backward beneath the posterior belly of the digastric and superior extremity of the sterno-mastoid muscle,‡ then passes horizontally backward along the base of the occiput, and divides into two principal branches, which break up into innumerable twigs upon the back part of the head.

Branches.—Its branches are: 1. A very small one to the sterno-mastoid muscle. 2. A *meningeal* branch, that enters the cranium through the jugular foramen. 3. The *descending cervical* (*princeps cervicis*), quite large, and the most interesting of the three, which descends beneath the muscles of the back of the neck, and inosculates with the deep cervical branches of the subclavian.

* Often a branch of the external carotid.

† Often a branch of the lingual.

‡ Sometimes external to this muscle.

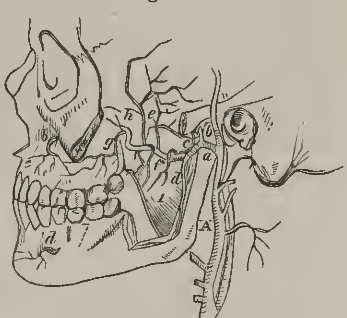
The POSTERIOR AURICULAR ARTERY (Fig. 208, 20) is generally small, and comes off a little above the preceding, and sometimes in common with it. It ascends beneath the parotid gland between the external ear and mastoid process, and divides into numerous small twigs that are distributed to the side of the head, and to the internal and external ear.

BRANCHES.—The most important of its branches is one that enters the stylo-mastoid foramen of the temporal bone, traverses the whole length of the aqueduct of Fallopius, and is distributed to the tympanum of the ear.

INTERNAL BRANCHES.—The INFERIOR or ASCENDING PHARYNGEAL ARTERY (Fig. 208, 21), the smallest of the named branches of the external carotid, arises from the inner aspect of this vessel nearly opposite the lingual, ascends almost vertically between the internal and external carotid, and at the base of the skull divides into a meningeal and a pharyngeal branch. The former enters the cranium through the jugular foramen, to be distributed to the dura mater; the latter passes inward, and is spent upon the pharynx and soft palate.

The INTERNAL MAXILLARY ARTERY (Fig. 208, 22), one of the two terminal divisions of the external carotid, supplies the deep parts about the base of the skull, and is the most difficult artery in the body to understand. In order to be properly exposed, it requires the removal of the zygoma and the anterior half of the ramus of the lower maxilla, as represented in the annexed plate, when by carefully following the vessel from its origin, a tolerably good idea may be obtained of its course and the numerous branches which it gives off. Commencing deep in the substance of the parotid gland, it curves around to the inner side of the condyle of the lower jaw, passing between it and the internal lateral ligament of the temporo-maxillary articulation; it then ascends a little,

Fig. 209.



The internal maxillary artery and its branches.

passes between the two pterygoid muscles, and lastly turns abruptly into the pterygo-maxillary fossa, where it gives off its terminal branches. In its course, it first lies between the neck of the condyle and the styloid process, the temporo-maxillary ligament intervening; far-

ther on, it is external to the dental and gustatory nerves, and then, having made a curve, the convexity of which projects somewhat between the two heads of the external pterygoid muscle, it enters the pterygo-maxillary fossa.

Branches.—Its principal branches are fourteen in number, and may be divided arbitrarily into three sets or classes:—

1. *Branches given off near the condyle of the lower jaw*	Tympanic, Middle meningeal, Inferior dental, Posterior deep temporal, Masseteric, Pterygoid, Small meningeal.
2. *Branches given off near the maxillary tuberosity*	Buccal, Anterior deep temporal, Alveolar, Infra-orbital.
3. *Branches given off within the spheno-maxillary fossa*	Vidian, Pterygo-palatine, Superior palatine, Spheno-palatine.

The *tympanic* is very small, is distributed to the external ear and temporo-maxillary articulation, and penetrates the cavity of the tympanum through the glenoid fissure.

The *middle meningeal* (Fig. 209, *b*), one of the largest of the branches, passes vertically upward upon the inner side of the condyle of the lower jaw, traverses the spinous foramen of the sphenoid bone, and spreads out in an arborescent manner upon the surface of the dura mater, being here received into grooves upon the inner side of the parietal and temporal bones. One of its branches within the cranium, sometimes called the *Vidian*, enters the aqueduct of Fallopius, and supplies the facial nerve.

The *inferior dental* (*d*, *d*) arises just beneath the preceding, descends, enters the dental canal, and, having furnished twigs to the several teeth along its course, emerges at the mental foramen. One of its numerous branches, called the milo-hyoid, leaves the main trunk just before it enters the dental canal, and, descending along the inner surface of the lower jaw, is distributed to the milo-hyoid muscle.

The *posterior deep temporal* (*e*), the next in order, ascends between the external pterygoid and temporal muscles, and then between the latter and the surface of the temporal bone, sending branches to all the adjacent structures.

The *masseteric* is a small twig that passes outward through the sigmoid notch of the lower jaw, to be distributed to the masseter muscle.

The *pterygoid*, three or four in number, and very small, are spent upon the muscles of the same name.

The *small meningeal* arises nearly opposite the inferior dental, passes between the pterygoid muscles and divides into two branches, one of which is distributed to the soft palate and nasal fossæ, and the other ascending above the external pterygoid, and entering the cranium through the oval opening of the sphenoid bone, supplies the fifth nerve and the adjacent dura mater.

The *buccal*, very small, often comes off in common with the inferior dental, runs a serpentine course between the ramus of the jaw and internal pterygoid muscle, and is distributed to the buccinator.

The *anterior deep temporal* ascends beneath the anterior border of the temporal muscle, to which, and the subjacent periosteum, it furnishes branches anastomosing with the middle and posterior temporal arteries.

The *superior dental* (*g*) descends forward upon the maxillary tuberosity, and divides into several branches, which supply the gums and teeth of the upper jaw; some of them penetrate the antrum and are distributed to its lining membrane.

The *infra-orbital* (*h*, *h*) frequently arises in common with the preceding. Commencing opposite the entrance to the spheno-maxillary fossa, it almost immediately enters the infra-orbital canal, emerges at the infra-orbital foramen, and is distributed to the soft parts of the cheek, anastomosing with the facial and transverse. While in the canal it sends a small twig over the inferior margin of the orbit to the lower eyelid, and another through the anterior dental canal of the canine and incisor teeth.

The *Vidian* or *pterygoid*, very small, traverses the Vidian canal, and is spent upon the pharynx and Eustachian tube.

The *pterygo-palatine*, situated below and internal to the preceding, also very small, passes through the canal of the same name, and is likewise distributed to the pharynx and Eustachian tube.

The *superior palatine* arises opposite the pterygo-maxillary fissure, descends through the posterior palatine canal, and is distributed to the mucous membrane of the mouth, covering the bony palate. It gives off numerous twigs to the soft palate and gums; and one, the *nasal branch*, which ascends through the anterior palatine canal to the nasal fossæ.

The *spheno-palatine*, the terminal twig of the internal maxillary, traverses the foramen of the same name, near the superior meatus of the nose, and is distributed to the nasal mucous membrane; one of its branches ramifies upon the nasal septum, and anastomoses with the nasal branch of the superior palatine.

The TEMPORAL ARTERY, the other of the two terminal divisions of the external carotid, has been already described.

The INTERNAL CAROTID ARTERY (Fig. 208) commences at the bifurcation of the common carotid, opposite the superior border of the thyroid cartilage, ascends almost vertically, in company with the internal jugular vein, to the base of the skull, where it enters the carotid canal in the petrous bone; having traversed this canal, it emerges within the cranium upon the side of the body of the sphenoid bone, perforates the cavernous sinus lying along the border of the pituitary fossa, and, running upwards beneath and upon the inner side of the anterior clinoid process, enters the fissure between the anterior and middle lobes of the brain, where it divides into the anterior and middle cerebral arteries. The cervical portion of the artery, although generally straight, is sometimes tortuous, especially near its entrance into the carotid canal, where the author has seen it folded back upon itself for the distance of three-fourths of an inch.

At its commencement, the internal carotid is placed upon the outer side of the external carotid, and being here contained in the triangle formed by the sterno-mastoid, omo-hyoid, and digastric muscles, and covered only by the platysma and skin, is easily found by the surgeon when the operation for tying it is necessary. A short distance above its origin it is crossed by the hypoglossal nerve and occipital artery, and obliquely by the external carotid; it then becomes placed beneath the digastric and stylo-hyoid muscles and parotid gland, the stylo-pharyngeal and stylo-glossal muscles intervening between it and the external carotid, internal to the jugular vein and anterior to the pneumogastric and sympathetic nerves.

Branches.—It gives off no important branch until it enters the carotid canal in the petrous bone, within which it sends off a small branch to the tympanum of the ear. Having reached the cavity of the cranium and perforated the cavernous sinus, and, before dividing into the two cerebral arteries heretofore mentioned, it sends off the *ophthalmic artery*, which accompanies the optic nerve through the optic foramen into the orbit.

The nearness of the internal carotid to the pharynx explains how it may be wounded in operations upon the lateral wall of this cavity, and more especially how it is occasionally cut in excision of the tonsils.

The subclavian artery (Fig. 208). The *right* subclavian originates from the brachio-cephalic or innominate artery behind the corresponding sterno-clavicular articulation, and the *left* from the arch of the aorta; both traverse the lower part of the neck in the same manner on their way to the arm, forming a curve with its convexity presenting upward. In their course both are crossed, in the neck, by the anterior scalene muscle, and are, therefore, considered as divided into three parts, the first extending from the origin of the vessel to the inner edge of this muscle; the second situated behind the muscle; and the third reaching from the outer border of the muscle to the first rib, over which the artery passes to enter the axilla.

First Portion.—The first portion of the *right* is about an inch in length, and, although deeply seated, is less so than the left; it passes almost directly outward, arching very slightly above the level of the clavicle; and has, lying in front of it, the extremities of the subclavian and internal jugular veins, the sterno-mastoid, hyoid, and thyroid muscles; it is crossed by the vertebral vein, pneumogastric,

phrenic, and branches of the sympathetic nerves; separated behind from the transverse process of the seventh cervical vertebra by the long muscle of the neck (*longus colli*), the recurrent laryngeal nerve, and a variable quantity of areolar and adipose tissue; and in contact below with the pleura, by which it is separated from the apex of the lung. The first portion of the *left* is as much longer than the right as the length of the innominate artery, say about an inch and a quarter; it ascends almost vertically from its origin within the chest, between the trachea and upper lobe of the left lung, to the lower part of the neck, where its relations are very similar to those of the right, except that it is more deeply seated, is covered to a greater extent by the pleura, and has the recurrent laryngeal nerve and thoracic duct lying to its inner side. The second and third divisions of the two arteries are the same.

Second Portion.—The second or middle portion is the highest part of the artery, and is situated between the anterior and posterior scalene muscles, from the latter of which it is separated by the brachial plexus of nerves, and by the former from the subclavian vein.

Third Portion.—The third portion curves outward and downward from the external border of the scalene muscles beneath the clavicle and over the first rib, traversing the triangular space formed by the clavicular portion of the sterno-cleido-mastoid, the posterior belly of the omo-hyoid, and the clavicle. As this is the portion usually selected by surgeons for the application of the ligature, the student should examine it carefully, both with reference to its relations and its depth from the surface. It is covered by the skin, platysma, and a quantity of areolar and adipose tissues, through which, and along the posterior border of the clavicle, runs the transverse artery of the neck, although this is by no means constantly the case. The subclavian vein is situated in front of and somewhat below the artery, and the brachial plexus of nerves immediately upon its superior and external border. The depth of the artery from the surface varies in different individuals from half an inch to an inch and a half, or even more, depending partly upon the prominence of the clavicle, and partly upon the development of adipose tissue; and the frequent difficulty and sometimes utter impracticability of ligating it without great danger on this account alone, must have struck every one who has performed many dissections of this region.

Branches.—The branches of the subclavian are—

The Vertebral,
Thyroid axis,
Internal mammary,
Superior intercostal, and
Deep cervical.

But, before proceeding farther, it should be mentioned that no artery in the body presents more numerous variations in reference to the number and arrangement of its branches; and the order here laid down, although, according to the author's observation the most common, may not be found to apply strictly to more than one subject out of three. The more common varieties will be referred to in the description of the individual branches and their subdivisions.

The vertebral artery (Fig. 208, 26), the first and largest of the branches of the subclavian, arises from the upper back part of the first portion of this vessel, where it lies in front of the transverse process of the seventh cervical vertebra. It ascends, inclining a little backward, enters the foramen in the transverse process of the *sixth* cervical vertebra, traverses the corresponding foramina of the several vertebræ above, and from the transverse process of the atlas makes a horizontal curve around the base of the corresponding superior articulating surface, to reach the spinal foramen of the occipital bone. Having entered the cranium, each artery passes forward and inward beneath the oblong medulla, and upon the basilar process of the occipital bone they both unite to form the basilar artery, as heretofore described. Before entering the transverse foramen of the sixth vertebra, it lies close upon the anterior surface of the transverse process of the seventh, immediately to the inner side of the scalene muscle, and behind the inferior thyroid artery. The artery of the left side has also a close relation in front with the thoracic duct, which here curves forward from behind the subclavian artery to terminate in the back part of the subclavian vein, just where it unites with the internal jugular to form the left innominate vein.

Branches.—The vertebral sends off a few small twigs to the structures with which it is in relation in the lower part of the neck, and from its horizontal curve upon the atlas a more considerable branch, called the *posterior meningeal*, to the dura mater. Its branches within the cranium have been already enumerated.

The left vertebral occasionally originates from the arch of the aorta, and not unfrequently either the one or the other is forced to

enter the foramen in the transverse process of the fifth or fourth cervical vertebra instead of the sixth.

The THYROID AXIS is a very short but large trunk arising from the anterior aspect of the first portion of the subclavian very near the inner border of the anterior scalene muscle, having the phrenic or diaphragmatic nerve lying along its outer side. At a short distance, generally not more than a quarter or an eighth of an inch from its origin, it divides into the following branches:—

The Inferior thyroid,
Ascending cervical,
Posterior scapular,
Supra-scapular.

The INFERIOR THYROID ARTERY (Fig. 208, 25′), the second in point of size, passes in a tortuous manner obliquely upward and inward behind the common carotid, internal jugular vein, pneumogastric, sympathetic, and recurrent laryngeal nerves, to the inferior extremity of the corresponding lobe of the thyroid gland (39) to which it is distributed. It not unfrequently originates directly from the subclavian, and generally sends a small branch to the back part of the larynx, and a few twigs to the trachea.

The ASCENDING CERVICAL ARTERY, the smallest of the four divisions of the thyroid axis, originates about as often from the inferior thyroid (so represented in Fig. 208, 40). It ascends almost vertically, lying close upon the anterior surfaces of the transverse processes of the vertebra, and is distributed to the adjacent muscles.

The POSTERIOR SCAPULAR, or TRANSVERSE CERVICAL ARTERY (Fig. 208, 29), the largest of the group, originates almost as frequently from the third portion of the subclavian. From the thyroid axis it curves transversely across the front of the anterior scalene muscle and diaphragmatic nerve, traverses the triangular space in which is contained the third portion of the subclavian artery and brachial plexus of nerves, sometimes resting immediately upon, and sometimes above them, and frequently running close along the posterior border of the clavicle. It then passes behind the clavicular attachment of the trapezius muscle, turns downward, and, running along the posterior border of the scapula, supplies all the adjacent muscles anastomosing with the subscapular, a branch of the axillary artery. Where it crosses the triangular space above mentioned it is, of course, in the way of an operation upon the third portion of the subclavian; and the frequency of this occurrence should be taken into consideration. In the neck, it gives off numerous small branches, the most important of which is the *superficial cervical*, which ascends behind the posterior border of the trapezius to the muscles upon the back of the neck.

When the posterior scapular originates from the third portion of the subclavian, it curves immediately backward in front of or through the brachial plexus of nerves; and, in this case, the superficial cervical is a branch either of the thyroid axis or first portion of the subclavian. It sometimes arises also in common with the supra-scapular.

The SUPRA-SCAPULAR ARTERY (Fig. 208, 30), smaller than the preceding, is almost constantly a branch of the thyroid axis, although occasionally of the preceding, as represented in the plate. From its origin it descends outward to gain the posterior border of the clavicle, along which it paases to

the superior edge of the scapula, crosses above the ligament of the suprascapular notch, and is distributed to the muscles upon the back of the scapula. This vessel is probably oftener in the way of an operation upon the third portion of the subclavian than the preceding.

The INTERNAL MAMMARY ARTERY (Fig. 208, 31), nearly as large as the vertebral, arises from the lower back part of the first portion of the subclavian opposite the thyroid axis, descends immediately into the cavity of the thorax across the posterior surface of the cartilage of the first rib, and thence along the border of the sternum, to be distributed to the muscles of the anterior part of the thorax and abdomen, as will be hereafter seen. It is covered internally by the pleura, crossed obliquely at its origin by the diaphragmatic or phrenic nerve, and separated from the inner end of the clavicle, behind which it is situated, by the corresponding innominate, or brachio-cephalic vein.

The SUPERIOR INTERCOSTAL ARTERY (Fig. 208, 28), occasionally absent, and not unfrequently a branch of the thyroid axis, or even of the vertebral or internal mammary, arises commonly from the inferior posterior aspect of the subclavian, close beneath the inner border of the anterior scalene muscle, descends beneath the pleura in front of the necks of the first and second ribs, and terminates by dividing into the first two intercostal arteries.

The DEEP CERVICAL ARTERY, often a branch of the preceding, ascends backward and outward between the transverse process of the last cervical vertebra and first rib, and divides into an ascending and descending branch, which supply the neighboring muscles of the back. The ascending branch anastomoses with the descending branch of the occipital.

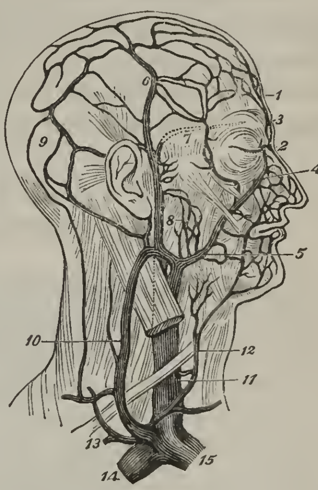
The VEINS of the neck, for the most part, correspond to the arteries, there being here generally one accompanying vein to each artery; and all assist in forming the two main trunks, the internal jugular and subclavian.

The INTERNAL JUGULAR (Fig. 210, 11) is the principal vein of the head and neck, and the accompanying vein of the common and internal carotid arteries. It commences at the base of the skull in the jugular foramen, being here continuous with the lateral sinus of the dura mater; descends along the outer side of the internal carotid artery as far as the hyoid bone, where it becomes inclosed in

the same sheath with the pneumogastric nerve and common carotid, lying to the outer side of the latter, and at the root of the neck it joins the subclavian vein to form the brachio-cephalic or innominate vein. Its size varies in different individuals, and often upon the two sides of the same person; but in general it is not less than three times as large as the artery which it accompanies, and when distended with blood or other fluid, overlaps the latter to a greater or less extent; a fact that should be borne in mind in operations upon either the internal or primitive carotid.

In the upper part of its course it receives a number of small veins, such, for instance, as the lingual, pharyngeal, a communicating branch from the external jugular,* occipital, &c., and opposite the hyoid bone it is joined by the facial and temporal (Fig. 210), in conjunction or separately; and here the vessel undergoes a considerable enlargement, corresponding to the large size of the primitive carotid, along which it lies in the rest of its course. About the middle of the neck it receives the middle and superior thyroid veins, and lower down, the inferior thyroid and anterior jugular veins.

Fig. 210.



Veins of the head and neck 1. Frontal vein. 2. Nasal vein or nasal arch. 3. Supra-orbitar vein. 4. Angular vein. 5. Facial vein. 6. Superficial temporal veins. 7. Middle temporal vein lying beneath the temporal fascia, and indicated by dotted lines. 8. Masseteric plexus. 9. Occipital veins. 10. External jugular. 11. Internal jugular. 12. Anterior jugular. 13. Scapular veins. 14. Subclavian vein. 15. Innominate or brachio-cephalic vein.

The ANTERIOR JUGULAR VEIN (Fig. 210, 12), often absent, and at best of no great size, is situated beneath the skin, a little way removed from the median line. It collects the blood from the anterior parts of the neck, descends at first vertically and then outward, and opens into the subclavian and internal jugular near their junction.

The SUBCLAVIAN VEIN (Fig. 210, 14) is situated at the root of the neck, behind and beneath the clavicle, and is generally somewhat larger than the internal jugular. From the axilla, where it is called the axillary vein, it crosses the first rib just in front of the inser-

* See description of external jugular, page 529.

tion of the anterior scalene muscle, and is therefore anterior to and some distance below the third portion of the subclavian artery. It passes directly in front of the first portion of this vessel, and joins the internal jugular at a right angle, to form the brachio-cephalic or innominate vein. Outside of the scalene muscle it receives the external jugular, and sometimes the posterior and superior-scapular veins; and at its junction with the internal jugular, on the right side, it is joined by the main trunk of the lymphatics of the corresponding side of the head and neck, and, on the left, by the thoracic duct from behind.

The VERTEBRAL VEIN, also partly seen in this dissection, accompanies the artery of the same name, and, leaving the foramen in the transverse process of the sixth cervical vertebra, descends forward in front of the first portion of the subclavian artery, to open into the corresponding portion of the subclavian vein.

NERVES OF THE NECK.

The principal nerves of the neck are the

Glosso-pharyngeal	and	branches;
Pneumogastric	"	"
Spinal accessory	"	"
Hypoglossal	"	"
Gustatory	"	"
Cervical plexus	"	"
Brachial plexus	"	"
And Sympathetic	"	"

The GLOSSO-PHARYNGEAL NERVE (Fig. 211, 20) is situated deep in the upper part of the neck. It is seen after the removal of the stylo-hyoid muscle and posterior belly of the digastric, descending forward from the jugular foramen between the internal jugular vein and internal carotid artery, beneath the styloid process, and then along the inner border of the stylo-glossal muscle, forming a curve with its concavity presenting upward. It sends branches in the neck to the stylo-pharyngeal, stylo-hyoid, digastric, and proper pharyngeal muscles, the tonsils, mucous lining of the pharynx, and muscular and mucous structure of the back part of the tongue.

BRANCHES.—The glosso-pharyngeal originates from the upper part of the groove between the olivary and restiform bodies of the oblong medulla, leaves

the cranium at the jugular foramen lying here internal to the jugular vein, and in front of the pneumogastric and spinal accessory nerves; it descends between the vein and internal carotid artery, curves forward in front of the artery beneath the styloid process and its three muscles, winds around the stylo-pharyngeal muscle, and thence along the inner aspect of the stylo-glossal to the tongue. Within the jugular canal it presents two enlargements or ganglia; the superior very small, and involving only a portion of the thickness of the nerve, called the *jugular ganglion;* and the inferior much larger, comprising all the fibres of the nerve, is lodged in a small depression of the petrous bone, and hence called the *petrous ganglion*, or the ganglion of Andersch. The branches of the nerve are the cervical, already mentioned, and offsets from the petrous ganglion. These are, 1, a small filament to join the auricular branch of the pneumogastric; 2, a similar one to the upper ganglion of the sympathetic; 3, one to the ganglion at the root of the pneumogastric; 4, a communicating branch to or from the facial nerve, perforating the digastric muscle; and, 5, one to the tympanum, called the *tympanic branch* or Jacobson's nerve. This last, by far the most interesting of the group, reaches the tympanum through a minute opening situated upon the anterior wall of the jugular notch, and having given off a small filament to form a plexus (*tympanic plexus*) with a twig from the sympathetic, is distributed to the lining membrane of the tympanum and Eustachian tube, sending branches also to the fenestra, carotid plexus, large superficial petrosal nerve, and otic ganglion.

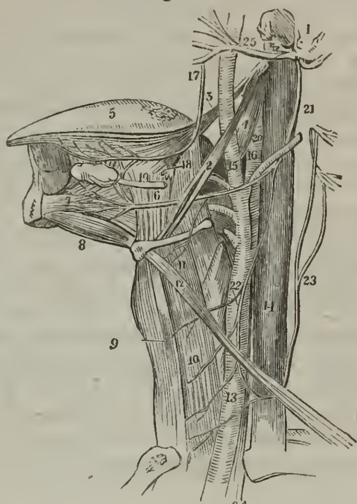
The PNEUMOGASTRIC NERVE (*nervus vagus, par vagum*) makes its appearance in the neck at the jugular foramen, upon the inner side of the internal jugular vein, descends inclosed in the same sheath with this vessel and the internal and primitive carotid arteries. At the root of the neck (Fig. 211, 24), in front of the first portion of the right subclavian artery, but parallel to the left, it inclines a little inward to reach the œsophagus, by the side of which it is continued into the thorax and abdomen.

BRANCHES.—The pneumogastric nerve originates from the groove upon the oblong medulla immediately below the spinal accessory, by a large number of filaments, which are collected into a flat bundle before leaving the cranium. In the jugular foramen the nerve is anterior to the vein, and presents a small enlargement, involving only a part of its thickness, called the ganglion of the root of the pneumogastric. From this ganglion one or two filaments are given off to the spinal accessory; another, called the *auricular branch*, receives a filament from the glosso-pharyngeal, enters a foramen in the petrous bone near the styloid process, traverses the bone across the aqueduct of Fallopius, and emerging between the mastoid process and external auditory meatus, is distributed to the integument and cartilage of the ear.

Immediately after leaving the jugular foramen, the pneumogastric receives the internal or accessory branch of the spinal accessory, and then enlarges into a reddish-gray ganglion of a cylindrical form, and nearly an inch (ten lines) in length, which comprises the whole thickness of the cord, excepting the spinal accessory branch, and is sometimes called the *plexiform ganglion* (Fig. 212, 11).

This ganglion, which, to distinguish it from the small one within the jugular foramen, is also called the *lower* or the *larger*, sends off minute com-

Fig. 211.



Nerves of the neck and tongue. 1. Part of the temporal bone. 2. Stylo-hyoid muscle. 3. Stylo-glossal muscle. 4. Stylo-pharyngeal muscle. 5. Tougue. 6. Hyoglossal muscle. 7. Genio-hyoglossal muscle. 9. Sterno-hyoid muscle. 10. Sterno-thyroid muscle. 11. Thyro-hyoid muscle, upon which is seen a branch of the hypoglossal nerve. 12. Omo-hyoid muscle, straightened by the removal of the loop of cervical fascia, through which its tendon plays. 13. Common carotid artery. 14. Internal jugular vein. 15. External carotid artery. 16. Internal carotid. 17. Gustatory branch of the fifth nerve, giving a branch to (18) the submaxillary ganglion. 19. Duct of submaxillary gland. 20. Glosso-pharyngeal nerve. 21. Hypoglossal nerve. 22. Descending branch of the hypoglossal. 23. Communicating branch from the cervical plexus. 24. Pneumogastric nerve emerging from between the internal jugular vein and common carotid artery to enter the chest. 25. Facial nerve, emerging from the stylo-mastoid foramen, and crossing the external carotid artery.

municating filaments, that form an intricate plexus beneath the base of the cranium with offsets from the facial, glosso-pharyngeal, spinal accessory, sympathetic and superior spinal nerves. It has also two considerable branches, one to the pharynx, called, consequently, the pharyngeal, and one to the larynx, named the superior laryngeal, to distinguish it from the inferior or recurrent laryngeal.

The PHARYNGEAL branch (Fig. 212, 13) descends behind the internal carotid artery to the back of the pharynx, and is distributed to the constrictor muscles and lining membrane of this cavity, forming here with branches from the glosso-pharyngeal, superior laryngeal, and sympathetic nerves, the pharyngeal plexus.

The SUPERIOR LARYNGEAL (Fig. 212, 15), at first deeply seated, descends forward, passing behind the internal carotid artery, and having sent communicating filaments to the superior ganglion of the sympathetic, lingual nerve, and pharyngeal plexus, divides into an external and an internal branch. The *external* division is distributed to the sterno-thyroid, sterno-hyoid, and crico-thyroid muscles, and thyroid body; the *internal* perforates the membrane between the hyoid bone and thyroid cartilage (thyro-hyoid membrane),

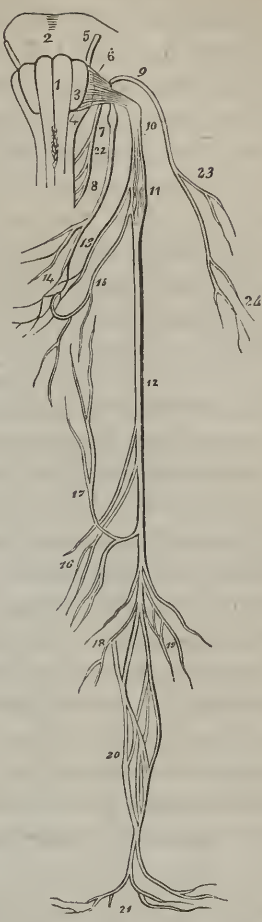
in company with the laryngeal artery, and is distributed to the mucous membrane lining the larynx.

From the origin of the superior laryngeal to the base of the neck, the pneumogastric furnishes only a few minute filaments, called *cervical cardiac branches* (Fig. 212, 16), which join the cardiac offsets of the sympathetic. The largest one of these comes off in the lowest part of the neck, and descends into the thorax, upon the right side, along the brachio-cephalic or innominate artery, and on the left over the arch of the aorta.

The INFERIOR or RECURRENT LARYNGEAL NERVE (Fig. 212, 17), arises from the pneumogastric, upon the right side, opposite the lower border of the first portion of the subclavian artery, behind which it ascends, and on the left, opposite the arch of the aorta, around which it winds, and returns to the neck. Upon either side it is situated in the groove, between the œsophagus and trachea, sends off a few filaments to the anterior part of the trachea, thyroid body, and lower part of the pharynx, and is finally distributed to the interior muscles of the larynx.

The branches of the pneumogastric within the thorax will be noticed when the contents of this cavity come under consideration.

Fig. 212.



Plan of the glosso-pharyngeal, pneumogastric, and spinal accessory nerves. 1, 3, 4. Oblong medulla. 1. Anterior pyramidal bodies. 3. Left olivary body. 4. Left restiform body. 2. Varolian bridge. 5. Facial nerve. 6. Origin of the glosso-pharyngeal nerve. 7. Ganglion of Andersch. 8. Trunk of the nerve. 9. Spinal accessory nerve. 10. Superior or smaller ganglion of the pneumogastric, situated in the jugular foramen. 11. Plexiform or larger ganglion of the pneumogastric. 12. Cervical portion of the pneumogastric. 13. Pharyngeal branch forming (14) the pharyngeal plexus, with a branch from the glosso-pharyngeal, and one from (15) the superior laryngeal nerve. 16. Cardiac branches. 17. Recurrent or inferior laryngeal. 18. Anterior pulmonary branches. 19. Posterior pulmonary branches. 20. Œsophageal plexus. 21. Gastric branches. 22. Origin of the spinal accessory. 23. Its branches to the sterno-mastoid muscle. 24. Its branches to the trapezius muscle.

The SPINAL ACCESSORY NERVE (Fig. 212, 9, and 213, 4) is found in the upper part of the neck beneath the sterno-cleido-mastoid muscle, and upon turning the muscle outward, the nerve is seen perforating its posterior border from above, downward and outward. It arises by several roots (Fig. 212, 22) from the side of the spinal cord, between the anterior and posterior roots of the spinal nerves, as low as the fourth cervical vertebra; it ascends and enters the cranium through the occipito-spinal foramen (*foramen magnum*), and again

leaves this cavity at the jugular foramen in the same sheath with the pneumogastric. Within the jugular foramen it communicates with the superior ganglion of the pneumogastric, and immediately beyond its exit divides into two branches; an *internal* or *accessory*, which joins the pneumogastric above, but does not enter into the formation of the lower ganglion of this nerve; and an *external*, larger one, which descends outward and backward, sometimes in front of and sometimes behind the internal jugular vein, perforates the sterno-mastoid muscle, supplying it with branches, and dips beneath the anterior border of the trapezius muscle, to which its terminal divisions, communicating with the cervical nerves, are distributed (Fig. 213, 5).

The HYPOGLOSSAL NERVE (*lingual nerve*) (Fig. 211, 21, and 213, 6) is seen in the upper part of the neck, curving transversely across the internal and external carotid arteries, following the lower border of the posterior belly of the digastric muscle, and then turning upward to reach the side of the tongue, beneath the posterior margin of the mylo-hyoid muscle. It originates from the outer side of the anterior pyramidal body of the oblong medulla, leaves the cranium through the anterior condyloid foramen, passes downward and forward between the internal jugular vein and internal carotid artery, runs along the lower border of the digastric muscle, then curves upward across the occipital and external carotid arteries, enters between the mylo-hyoid and lower portion of the hyoglossal muscles, and is continued in the substance of the genio-hyoglossal to the tip of the tongue, being distributed solely to the muscular tissue of this organ. Soon after leaving the cranium, it has communicating filaments with the pneumogastric and first ganglion of the sympathetic nerve, and gives off near the occipital artery a long descending branch, called technically the *descendens noni* (Fig. 211, 22), which descends upon the sheath of the jugular vein and carotid artery, forming about the middle of the neck a loop with a branch from the pneumogastric or cervical nerves. From this loop, the convexity of which is directed downward, filaments are given off to the omo-hyoid, sterno-hyoid, and sterno-thyroid muscles.

The ultimate branches of the hypoglossal nerve supply the stylo-glossal, thyro-hyoid, hyoglossal, and genio-hyoglossal muscles. It also sends filaments of communication to the gustatory nerve.

The GUSTATORY OR LINGUAL BRANCH OF THE INFERIOR MAXILLARY NERVE (Fig. 211, 17) makes its appearance deep in the upper part

of the neck, upon the inner side of the base of the lower jaw near its angle, whence it turns forward across the upper part of the hyo-glossal muscle above the submaxillary gland, and continuing beneath the mucous membrane of the mouth and above the mylo-hyoid muscle, is distributed to the mucous covering of the tongue as far as its tip. In its course, it sends branches to the palate, pharynx, gums, sub-maxillary, and sublingual glands.

The Sympathetic Nerve.—The central portion of this nerve consists of a small knotted cord which lies upon each side of the front of the spinal column, and extends from the base of the skull to the coccyx. The cervical portion, seen in this dissection, descends from the base of the cranium close along the sides of the bodies of the vertebræ, behind the common sheath of the jugular vein, carotid artery, and pneumogastric nerve, and enters the thorax over the first portion of the subclavian artery. In its course, it presents three ganglionic enlargements with numerous branches of communication and distribution. The *superior* and largest of these ganglia is situated upon the second and third cervical vertebræ; it is about an inch in length, but differs very greatly in different subjects, fusiform in shape, of a reddish-gray color, and smooth surface. The *middle*, very small and frequently wanting, is situated opposite the fifth or six vertebra in front of the inferior thyroid artery, and varies in shape in different individuals. The *inferior*, larger than the preceding and of a crescentic shape, may be found either upon the transverse process of the seventh cervical vertebra, or between this and the first dorsal vertebra, near the head of the first rib and behind the vertebral artery.

Branches.—The superior cervical ganglion gives off superior, inferior, internal, external, and anterior branches. The *superior*, two in number, enter the cranium through the carotid canal of the petrous bone. They form upon the internal carotid artery and cavernous sinus the carotid and cavernous plexuses from which branches are sent to the tympanum, and communicating filaments to the spheno-palatine, sixth, and Jacobson's nerves, Gasserian ganglion, orbital plexus, and lenticular ganglion. The *inferior* is the central cord that descends to the middle ganglion. The *anterior* are very numerous, and accompany the branches of the external carotid artery, and also form communications with the spinal accessory, glosso-pharyngeal, pneumogastric, and hypoglossal nerves. The *external* pass directly outward, and join the first three or four cervical nerves as they emerge from the spinal canal. The *internal* are very numerous; some of them accompany branches of the external carotid artery to the tongue, thyroid body, face, &c.; some go to the pharynx and larynx, and one to the heart. This last mentioned, called the *upper cardiac nerve*, arises from the lower extremity of the ganglion, descends behind the sheath of the jugular vein and carotid

artery, but in front of the inferior thyroid artery, and enters the chest sometimes in front of and sometimes behind the first portion of the subclavian artery, to join the great cardiac plexus upon the concavity of the arch of the aorta.

The middle ganglion communicates above and below with the other two; externally, with the third, fourth, and fifth cervical nerves; and from its inner side sends off the *middle cardiac nerve*, which descends behind the sheath of the common carotid artery either in front of or beneath the first portion of the subclavian artery, and joins the deep cardiac plexus above mentioned.

The inferior ganglion sends a common trunk to the middle, and communicating filaments to the diaphragmatic, brachial, and recurrent laryngeal nerves; and from its internal aspect originates the *inferior cardiac nerve*, which descends to the cardiac plexus, communicating in its course with the pneumogastric and recurrent laryngeal nerves.

The *cervico-spinal nerves*, eight in number on each side, emerge from the spinal canal through the corresponding intervertebral foramina, and divide into anterior and posterior branches. The anterior branches of the first four unite to form the cervical plexus, and those of the inferior four, the brachial plexus. The posterior branches are distributed to the muscles of the back.

The CERVICAL PLEXUS (Fig. 213) is situated upon the side of the upper part of the neck, beneath the posterior border of the sterno-cleido-mastoid muscle, and in front of the lateral attachments of the muscles of the back of the neck. It is formed by the union of the anterior divisions of the upper four cervical nerves, each of which, except the first, divides into a descending and an ascending branch that communicate together above and below.

BRANCHES.—Its branches belong to a superficial and deep set. The *superficial* set consists of ascending and descending branches, the former comprising the superficial cervical, auricular, and small occipital nerves, and the latter the supra-clavicular nerves, all of which have been already mentioned. The *deep* set consists of communicating filaments to the pneumogastric, hypoglossal, glosso-pharyngeal, and sympathetic nerves, and numerous muscular branches, namely, to the trapezius, elevator of the scapula, sterno-mastoid, sterno-hyoid, omo-hyoid, sterno-thyroid, posterior scalene muscles, and diaphragm. The most interesting of these is the diaphragmatic, and the branch to the subhyoid muscles.

The *diaphragmatic* or *phrenic nerve* (Fig. 213, 9, 9) is derived from the anterior divisions of the third and fourth, and sometimes also from the fifth cervical nerves. It descends obliquely inward over the anterior scalene muscle, and enters the thorax across the root of

the internal mammary artery. Within this cavity, it is bound by the pleura to the side of the pericardium, along which it passes to

Fig. 213.

Cervical and brachial plexuses of nerves of the right side. 1. Facial nerve. 2. Pneumogastric nerve. 3. Internal carotid artery. 4. Spinal accessory nerve. 5. Anastomoses of the spinal accessory nerve with the cervical plexus. 6. Hypoglossal nerve, giving off its descending branch. 7. Anterior branch of the first cervical nerve, anastomosing with the hypoglossal nerve and with the pneumogastric. 8. Descending cervical branch of the cervical plexus, anastomosing with the corresponding branch of the hypoglossal. 9. Phrenic nerve. 10, 10. Deep cervical branches of the cervical plexus. 11. Brachial plexus. 12. Branch to the subclavian muscle, sending a filament to the phrenic nerve. 13. Anterior thoracic branches. 14. Lateral thoracic branch, or the branch to the great serrate muscle. 15, 16, and 17. Subscapular branches going to the subscapular, latissimus, and greater teres muscles. 18. Axillary artery, surrounded by a sort of sheath formed by branches going to the arm. 19. Brachial branches.

its ultimate distribution upon the under surface of the diaphragm. It sends also a small branch to the liver, supra-renal capsule, and inferior cava vein.

The *subhyoid branch* of the cervical plexus, called technically the *communicans noni* (Fig. 213, 8), arises from the second and third nerves, descends inward beneath the sterno-cleido-mastoid muscle, and, about opposite the thyroid body, joins the descending branch of the hypoglossal upon the sheath of the carotid artery and jugular vein in the form of a loop, from which branches are given off to the depressor muscles of the larynx. This nerve is often double.

The BRACHIAL PLEXUS (Fig. 213, 11) is situated in the lower external part of the neck, and is formed by the union of the anterior divisions of the lower four cervical nerves and first dorsal, which emerge from the corresponding intervertebral foramina between the anterior and posterior scalene muscles. It is placed above and external to the third portion of the subclavian artery, and beneath the posterior belly of the omo-hyoid muscle; it is at first broad and flat, but becomes narrower and more closely related to the artery as it descends over the first rib beneath the clavicle toward the axilla.

Its branches above the clavicle are the posterior thoracic, supra-scapular, and small filaments to the adjacent muscles and diaphragmatic nerve.

The *posterior* or *lateral thoracic* (Fig. 213, 14) arises close to the spine in the substance of the posterior scalene muscle, and descends behind the plexus to the lateral parts of the thorax, and is distributed principally to the great serrate muscle.

The *supra-scapular* (13) comes from the upper part of the plexus, descends obliquely beneath the anterior edge of the trapezius muscle, passes through the supra-scapular notch, and is distributed to the muscles on the back of the scapula. The axillary branches will be seen hereafter.

THE THYROID BODY.

Before leaving the neck the student should examine this singular organ (sometimes called a *gland*, although it possesses no excretory duct, and its function is entirely unknown), situated upon the front and sides of the upper part of the trachea, beneath the sterno-hyoid and thyroid muscles (Fig. 208, 39). It is of a brownish or dusky-red color, nearly symmetrical, but unlike any familiar object in shape (unless it be a pair of old-fashioned saddle-bags). It consists of two large lateral lobes, and an intervening narrow flattened portion, denominated the *isthmus*. The *lobes* are of a flattened pyriform shape, and about two inches in length, the right somewhat the larger; they rest upon the sides of the trachea, the lower or large extremity reaching as low as the sixth ring of this tube, the apex

touching the side of the thyroid cartilage, and the posterior, or outer margin, in contact with the sheath of the common carotid artery and jugular vein, the left touching also the side of the œsophagus.

The *isthmus* is of very variable shape and size, but in general about half an inch broad and quarter of an inch thick. It rests upon the second, third, and fourth rings of the trachea, and is continuous with the lateral lobes near their larger extremities. Frequently, however, it is quite large, constituting a *middle lobe*, which is prolonged upward in the median line, in a pyramidal form, sometimes as far as the lower margin of the thyroid cartilage. A flattened muscle (elevator of the thyroid gland) sometimes extends from the upper border of the isthmus to the hyoid bone, only a single instance* of which, however, has come under the author's observation.

Structure.—The thyroid body is composed in part of a strong, transparent, fibrous capsule, from the inner surface of which proceed numerous processes or septa, which divide the organ imperfectly into small irregular lobules. These lobules are farther divisible into minute closed vesicles of various forms, which have well-marked fibrous walls, and inclose a fluid containing numerous granular nuclei of a rounded or oval form, and a few perfect cells of larger size.

The *vessels* of the thyroid body are numerous and large. Its *arteries*, four in number, two superior and two inferior, come from the external carotids and subclavians; to which is occasionally added a fifth, called the *middle thyroid*, that generally arises from the innominate, sometimes from the arch of the aorta, between the innominate and the left carotid (Fig. 208); it ascends in front of the trachea, and is never of any very great size. Notwithstanding its small size, this artery might give rise to some inconvenience if cut in tracheotomy, an accident that could hardly be avoided. The *veins* are very large, and form on each side a superior, middle, and inferior trunk, the first two pairs of which open into the internal jugulars, but the inferior form an intricate anastomosis in front of the trachea, and terminate, the right in the inferior cava vein, and the left in the left brachio-cephalic. The *lymphatics* are very numerous and very large. The *nerves* are few and small, and come from the pneumogastric and sympathetic.

* In this case the muscle was nearly or quite as large as the sterno-hyoid, and proceeded directly up the middle of the neck in front of the larynx to the hyoid bone.

The function of this body has yet to be discovered. Its size in the fœtus is relatively much greater than in after life, and is somewhat greater in the female than in the male. Its enlargement or hypertrophy, which is sometimes enormous, constitutes the disease called *goître*.

THE CAVITY OF THE MOUTH.

The cavity of the mouth is of an oval shape, the large extremity of the oval presenting forward, and its axis, unlike that of any of the inferior animals, is directed horizontally from before backward. It is bounded *above* by the hard palate; *below* by the tongue and the mylo-hyoid muscles; *in front* by the gums, dental arches, and lips; *laterally* by the gums, teeth, and cheeks; and *posteriorly* by the soft palate. It communicates in front with the external air, and behind with the pharynx by a considerable opening, called the *isthmus of the fauces*, which will be more particularly described hereafter.

The LIPS, the two musculo-membranous doors that guard the external opening to the mouth, and whose form and uses are familiar to every one, consist principally of skin, muscle, and mucous membrane, together with a layer of little glandular organs, and numerous vessels and nerves. The *skin*, the most external of these structures, is dense and thick, and, in the male adult, covered with hair; it is closely adherent to the subjacent muscular layer, and at the free margins of the lips is continuous with the mucous lining of the mouth. The *mucous membrane* covers the posterior or internal surfaces of the lips, and forms in the middle line of each a small vertical fold or *bridle* (*frænum*), by which they are connected to the gums. The *glandular layer* is situated beneath the mucous membrane, and consists of numerous small spherical glands, about the size and shape of a grain of wheat, arranged very closely side by side, and opening by small, separate, excretory ducts upon the free surface of the mucous membrane. The *muscular layer* is subjacent to the skin, and is composed of the orbicular or sphincter muscle, and the adjacent extremities of the twenty-five different muscles that are inserted into its outer margin. The *arteries* are the four coronary branches of the facial. The *veins* follow the course of the arteries. The *nerves* to the skin and mucous mem-

brane are branches of the fifth or trigeminal, and of the facial, to the muscular tissue.

The CHEEKS are continuous with the lips, and are composed essentially of the same structures; but the muscular layer is formed by the buccinator, and the glands are more scattered. The mucous membrane, like that of the lips, is covered by a scaly or tessellate epithelium, and perforated upon each side about its middle and opposite the second molar tooth of the upper jaw by the duct of the parotid gland.

The *hard palate*, or roof of the mouth, is formed by the palate processes of the superior maxillary and palate bones; it is covered by mucous membrane, beneath which is a dense fibrous or periosteal membrane, and between the two a number of glands like those found in the lips and cheeks. Its surface is slightly concave, but uneven, traversed in the middle line from before backward by a line corresponding to the union of the bones, and marked just behind the middle incisor teeth by a little papilla, which corresponds to the inferior termination of the naso-palatine canal, and is said to be endowed with a peculiar sensibility.*

The GUMS are formed by the alveolar arches covered by dense periosteum and mucous membrane, continuous with that of the lips and cheeks, but remarkable for its insensibility. The mucous membrane is closely in contact with the necks of the teeth, but not adherent to them; the fibrous membrane, however, dips into and lines the sockets, and thus wedges, as it were, the roots of the teeth firmly in their places.

THE TONGUE.

The tongue, the special organ of the sense of taste, is oval in shape, flattened from above downward, pointed at its anterior extremity, and attached by its posterior extremity to the body of the hyoid bone. Its superior surface, lateral margins, and tip are free, and covered by mucous membrane; its inferior surface is continuous with the genio-hyoglossal, hyoglossal, styloglossal, and lingual muscles. The mucous membrane of the tongue is continued from the superior surface behind upon the anterior surface of the epiglottis, forming, in the middle line, a triangular fold, called the bridle (*frænum*) *of the epiglottis*. A short distance external to the

* Quain.

bridle, and separated from it by a little depression, are two smaller folds, one on each side, attached to the margins of the epiglottis. From the under surface of the organ, upon each side, the membrane is reflected upon the sublingual gland and the inner surface of the mylo-hyoid muscle near its insertion, and thence to the inner surface of the lower jaw, forming the floor of the mouth. In front it is extended from beneath the tip of the organ to the inner aspect of the symphysis of the lower jaw, in the form of a tolerably large triangular fold, called the *bridle of the tongue*, upon each side of which may be observed the orifice of the duct of the submaxillary gland, and those of the sublingual.

The *superior* or *dorsal surface* of the tongue is divided into two lateral halves by a longitudinal groove, and studded with numerous little eminences or *papillæ*, of which three sizes may be recognized. The largest, called the *calyciform papillæ* (*papillæ circumvallatæ*), vary from fifteen to twenty in number, and are situated posteriorly a short distance in front of the epiglottis, where they are arranged in two rows, like the branches of the letter V; the apex of the angle presents backward, and is marked by a deep mucous follicle (*foramen cæcum*). Each papilla is conoidal, and attached by its apex to the bottom of a cup-shaped depression or calyx. The middle sized, called the *fungiform papillæ*, are scattered over the whole of the surface, but are most numerous near the tip; they are of a deep-red color, flattened on top, and attached by a narrow pedicle. The smallest are either *conical* or *filiform*. They cover the whole of the forepart and middle of the surface, and are attached obliquely from before backward, as may be proved by passing the hand over the organ from behind forward, when they will be made to stand on end.

Behind the papillæ, upon the root of the organ, are a number of large mucous follicles, readily distinguished by their circular orifices.

Structure.—The substance of the tongue consists of animal muscular tissue, and a variable quantity of adipose substance. The muscular fibres are either intrinsic or extrinsic—that is, they belong exclusively to the organ, or are derived from surrounding muscles. The *intrinsic* fibres are longitudinal and transverse; the former constitute two layers, attached behind to the body of the hyoid bone, from which they pass forward to the tip of the organ and inclose the transverse. The *extrinsic* fibres are continuations of the various muscles that are inserted into the under surface of the organ, and

are intimately blended with the former. The *arteries* of the tongue are the *ranine* or lingual (one upon each side) branches of the facial. The *nerves* are derived from three sources; the fifth or trigeminal supplies the mucous membrane and papillæ of the forepart and middle of the organ; the glosso-pharyngeal is distributed upon its back part and the contiguous fauces, but also sends a branch forward to the under surface of the tip; the hypoglossal or lingual supplies its muscular tissue throughout. The glosso-pharyngeal and lingual, or gustatory branch of the fifth, endow the organ with its special sense,* the sense of taste, which is generally supposed to be only a modification of ordinary sensation; the hypoglossal is a simple motor nerve.

Dissection to expose the Fauces, Pharynx, and Larynx.—Having removed the muscles, vessels, and nerves from both sides of the neck, divide the trachea and œsophagus about an inch below the larynx, and turn them upward from the front of the spine as far as the base of the skull; then apply a saw flatwise, and as close as possible to the front of the spine, and divide the skull vertically upward. Cleanse the parts well, and stuff the mouth and pharynx with curled hair or moss, in order to get an idea of the natural form of the parts, and to facilitate the dissection of the muscles of the pharynx.

THE PHARYNX.

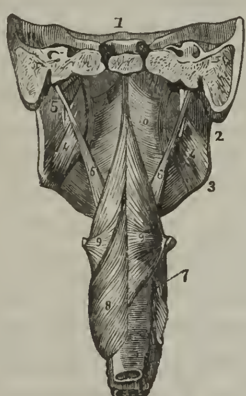
The pharynx is a musculo-membranous pouch, somewhat funnel-shaped, and situated in the middle line of the upper part of the neck, immediately below the basilar process of the occipital bone, and in front of the cervical vertebræ. It is separated from the latter by the anterior straight muscles of the head, to the anterior surface of which it is attached by rather loose areolar tissue. Laterally, it is in relation *above* with the internal pterygoid muscle, internal carotid artery, glosso-pharyngeal, hypoglossal and spinal accessory nerves; *below*, with the external carotid artery and its branches, and numerous lymphatic glands; and, *in its whole length*, with the internal jugular vein and pneumogastric nerve. In front it is attached to the pterygoid processes of the sphenoid bone, the pterygo-maxillary ligament, molar ridge of the lower jaw, hyoid bone, thyroid and cricoid cartilages, and upper rings of the trachea. Its lower extremity is continuous with the commencement of the œsophagus opposite the fifth cervical vertebra.

* Carpenter.

The walls of the pharynx consist of three membranous muscles, a strong fibrous layer, and a lining of mucous membrane. The muscles, called, from their action, constrictors, are external, and should be examined first, and may be exposed by carefully removing the areolar tissue from its posterior surface, the cavity being stuffed as before directed.

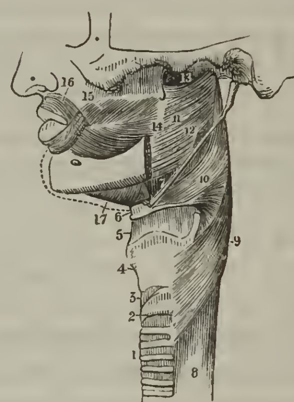
The INFERIOR CONSTRICTOR MUSCLE (Fig. 214, 8, and 215, 9), the posterior and lowest of the three, arises upon each side, from the two upper rings of the trachea and the lateral surfaces of the cricoid and thyroid cartilages; it curves upward and backward, overlapping the lower half of the middle constrictor, and is inserted with

Fig. 214.



A posterior view of the muscles of the pharynx. 1. A vertical section carried transversely through the base of the skull. 2. The posterior border of the ramus of the lower jaw. 3. The angle of the inferior maxilla. 4. The internal pterygoid muscle. 5. The styloid process of the temporal bone giving attachment to 6, the stylo-pharyngeal muscle. 7. The inferior extremity of the stylo-pharyngeal muscle attached to the superior horn and posterior border of the thyroid cartilage. 8. The inferior constrictor of the pharyux. 9. The middle constrictor of the pharynx, partly covered on the left side by the inferior constrictor. 10. The superior constrictor of the pharynx. 11. The external surface of mucous membrane of pharynx, uncovered by muscular fibres.

Fig. 215.



A side view of the muscles of the pharynx. 1. The trachea. 2. The cricoid cartilage. 3. The crico-thyroid membrane. 4. The thyroid cartilage. 5. The thyro-hyoid membrane. 6. The hyoid bone. 7. The stylo-hyoid ligament. 8. The œsophagus. 9. The inferior constrictor. 10. The middle constrictor. 11. The superior constrictor. 12. The stylo-pharyngeal muscle passing down between the superior and middle constrictor. 13. The upper concave border of the superior constrictor; at this point the muscular fibres of the pharynx are deficient. 14. The pterygoid maxillary ligament. 15. The buccinator muscle. 16. The orbicular muscle of the mouth. 17. The mylo-hyoid muscle.

its fellow of the opposite side into the middle line of the pharynx behind and below.

DISSECTION.—Dissect the inferior constrictor of one side as represented in Fig. 214, and the next muscle of the same side will be brought wholly into view.

The MIDDLE CONSTRICTOR MUSCLE (Fig. 214, 9, and 215, 10), triangular or fan-shaped, arises from the two horns (cornua) of the hyoid bone and the stylo-hyoid ligament, curves backward and spreads outward, and is inserted with its fellow of the opposite side into the upper two-thirds of the middle line of the pharynx behind, and into the basilar process of the occipital bone. It is overlapped below by the preceding muscle, and overlaps above the lower part of the next, which is

The SUPERIOR CONSTRICTOR (Fig. 214, 10, and 215, 11). This thin and quadrilateral muscle arises from the internal pterygoid plate, the pterygo-maxillary ligament, and the posterior extremity of the lower jaw, curves almost horizontally backward, and is inserted with its opposite fellow into the upper half of the middle line of the pharynx behind, and into the basilar process of the occipital bone.

USE.—The constrictor muscles, as their name imports, diminish the cavity of the pharynx, by which movement, which is only partly under the control of the will, substances received from the mouth are grasped, and then, by an elevation of the pouch produced by the stylo-pharyngeal and the elevator muscles of the larynx and tongue, they are forced down into the œsophagus.

DISSECTION.—Dissect the constrictors carefully aside, and a strong aponeurosis, or fascia, will be brought into view.

The *pharyngeal aponeurosis* is the middle coat of the pouch, and similar in all respects to the fibro-areolar coat of the intestinal canal. It is attached above to the basilar process of the occipital bone, the apex of the petrous bone, and pterygoid processes of the sphenoid, and extends downward between the mucous and muscular layers, becoming thinner as it descends, and is continuous with the fibro-areolar coat of the œsophagus.

DISSECTION.—Open the pharynx behind by a median incision extending nearly its whole length, and its internal or mucous surface will be exposed, together with the several openings of communication presently to be mentioned.

The *mucous membrane* of the pharynx is tolerably thick opposite the basilar process of the occipital, but becomes thinner and paler lower down. In front of the cervical vertebræ, and opposite the back part of the mouth, it is thrown into a number of vertical folds, and is provided with glands like those of the lips and cheeks. Ac-

cording to Henlé, its epithelium is columnar, and ciliated as low down as upon a level with the floor of the nasal cavities; but, below this point, it is squamous and destitute of cilia.*

Vessels.—The pharynx is supplied principally by the ascending pharyngeal, a branch of the external carotid. Its veins form a considerable plexus, and open into the internal jugular and superior thyroid vein.

The *nerves* are very numerous, and form an intricate plexus between the constrictor muscles. They are branches of the glosso-pharyngeal, pneumogastric, and sympathetic. On account of its large nervous connections, the pharynx is possessed of great sensibility, and of sympathies hardly equalled by any other part of the alimentary canal.

Upon each side above, the pharynx communicates with the ear through the Eustachian tube; in front, with the nasal cavities by means of the two large openings called the posterior nares; with the mouth, through the isthmus of the fauces; and with the larynx, through the opening of the glottis, and at its inferior extremity with the commencement of the œsophagus.

Fig. 216.

The pharynx laid open from behind. 1. A section carried transversely through the base of the skull. 2, 2. The walls of the pharynx drawn to each side. 3, 3. The posterior nares, separated by the vomer. 4. The extremity of the Eustachian tube of one side. 5. The soft palate. 6. The posterior pillar of the soft palate. 7. Its anterior pillar; the tonsil is seen in the niche between the two pillars. 8. The root of the tongue, partly concealed by the uvula. 9. The epiglottis, overhanging (10) the superior opening of the larynx. 11. The posterior part of the larynx. 12. The opening into the œsophagus. 13. The external surface of the œsophagus. 14. The trachea.

The *posterior nares* (Fig. 216, 3) are the two large oval openings situated in front of the upper part of the pharynx, and communicating between this cavity and the nasal fossæ. They are bounded above by the body of the sphenoid bone, laterally by the internal pterygoid plates, and below by the continuation of the hard and soft palate, and separated in the middle line by the posterior edge of the vomer.

The *isthmus* of the fauces is the constricted opening communicating with the cavity of the mouth. It is situated beneath the posterior nares, and is bounded above by the soft

* Quain.

palate and uvula, laterally, by two folds of mucous membrane called the half arches of the palate, and below, by the root of the tongue.

The SOFT PALATE is a quadrilateral, fleshy, movable, and imperfect partition or valve, situated between the mouth and the pharynx. It forms the extension of the hard palate, from the posterior margin of which it curves downward and backward, and presents for consideration an anterior and a posterior surface, and a free border.

The *anterior* or *inferior surface* is concave, and forms the posterior boundary of the cavity of the mouth; it is marked by a median line or raphé indicating the original union of its two halves. Beneath its mucous membrane, which has a squamous epithelium, are a few glands (*palatine glands*) similar to those found in the lips and cheeks. The *posterior* or *superior surface* is convex, and forms the continuation of the floor of the nasal fossæ, and part of the anterior boundary of the pharynx; its mucous membrane is covered with a squamous or tesselate epithelium below, but changes to ciliated columnar near the nares. The palatine glands are more numerous upon this than upon the anterior surface.

The *free edge* of the soft palate is thin, and presents in the middle line a small dependent conical process, called the *uvula*. From the base of the uvula the edge curves outward to the lateral boundaries of the fauces, where it forms upon each side two distinct folds, called the *half arches*, or *pillars* of the palate; these diverge from above, the *anterior* passing downward and forward to the side of the tongue, and the *posterior* downward and backward to the side of the pharynx. They consist of mucous membrane inclosing muscular fibres, and between the two is a triangular excavation which contains the tonsil.

STRUCTURE.—The soft palate and uvula are composed principally of muscular tissue, covered by mucous membrane, and provided with little glands.

To expose the muscles of the palate, it is necessary to remove carefully the mucous membrane and glands only from the posterior surface of the organ.

THE MUSCLES OF THE PALATE.—The muscles of the palate are five in number upon each side; two superior, called the elevator and tensor of the palate; two inferior, named the palato-glossal and palato-pharyngeal; and one in the middle line, called the elevator of the uvula, which forms, with its fellow of the opposite side, the azygos muscle.

The *elevator of the palate* (*levator palati*), thick and rounded above and flattened below, arises from the apex of the petrous bone behind the Eustachian tube, descends along the outer side of the posterior nares, turns inward, and is inserted into the middle of the soft palate beneath the mucous membrane of its posterior surface. Its name indicates its use.

The *circumflex* or *tensor muscle of the palate* (*tensor palati*), thin and delicate, is seen by removing the preceding, to which it is external. It arises from the little scaphoid fossa at the root of the internal pterygoid plate, from the anterior surface of the Eustachian tube, and from the spinous process of the sphenoid bone. It descends, and ending in a tendon which turns over the hook-like (*hamular*) process of the internal pterygoid plate, is inserted by an expanded fascia into the under surface of the palate process of the palate bone and adjacent part of the soft palate.

The *elevator* or *retractor of the uvula* arises from the spine of the palate bone on each side, descends, and unites with its fellow of the opposite side in the median line of the uvula. The two form what was once considered to be only one muscle, known as the *azygos uvulæ.*

The *palato-glossal muscle* is contained in the anterior half arch of the palate; it is long and slender, arises from the inferior surface of the soft palate, descends forward, and is inserted into the side of the tongue.

The *palato-pharyngeal muscle* is contained in the posterior half arch; it arises from the inferior surface of the soft palate, descends backward, and is inserted into the side of the pharynx.

USES.—The elevator raises the palate, and is of great use in preventing the passage of food, water, &c. into the posterior nares and Eustachian tube in deglutition and vomiting. The tensor assists the elevator by spreading the palate out, and making it tense. The palato-glossal and palato-pharyngeal narrow the isthmus of the fauces; and, by successive contraction, throw the food into the pharynx. The azygos retracts the uvula.

The TONSIL is an oval-shaped body about the size of an almond kernel (hence, sometimes called the amygdala), which is situated in the triangular interval between the anterior and posterior half arches of the palate, and forms a slight irregular projection upon the mucous surface. Its free surface is covered by mucous membrane, and perforated by twelve or fifteen small foramina, which are its excre-

tory orifices. Its deep surface, which rests upon the internal surface of the superior constrictor muscle of the pharynx, corresponds to the angle of the jaw, and is separated from the internal carotid artery by the fibres of the constrictor, and a strong layer of fibro-areolar tissue. When the organ is enlarged, as is frequently the case, it presses closely upon the internal carotid, and is brought into relation also with the external carotid and commencement of the facial artery.

STRUCTURE.—The tonsil is only a collection of muciparous follicles or crypts, which are held together by areolar tissue and communicate with the throat by twelve or fifteen little ducts. It secretes a mucous fluid for lubricating the surrounding parts.

VESSELS.—The tonsils receive considerable branches from the facial and ascending pharyngeal. Their *veins* form a plexus, and terminate in the pharyngeal plexus. Their *nerves* are derived from the glosso-pharyngeal and fifth pair.

THE NASAL CAVITIES.

The nasal cavities are two large fissure-like excavations, situated upon both sides of the middle line of the deep parts of the face. They extend from the nostrils or anterior nares in front to the pharynx behind, and from the upper surface of the hard palate to the cribriform plate of the ethmoid bone. They are divided by a complete median partition or septum. The general form of the interior surface of these cavities, and the arrangement of the several bones entering into their structure, have been already described (see page 161), but, in the recent state, they present important differences, and demand, therefore, a careful examination. For this purpose, it is necessary to make a vertical antero-posterior section of the face, a little to one side of the middle line, so as to leave the nasal septum entirely upon one side, whilst upon the other is shown the external wall of the opposite cavity, as represented in Fig. 217.

In the skeleton state, the entrance to the nasal cavities, called the *anterior nares*, is a large oval opening, with sharp, well-defined edges, but, in the recent state, this is entirely concealed from view by cartilaginous structures forming the prominent part of the nose. The number of these cartilaginous pieces is five to each nostril, and one central piece, which completes the nasal septum in front. They

are joined together, so as to admit of slight motion, by strong areolar tissue, and covered externally by muscles and skin.

The nasal cavities are lined throughout by a very vascular mucous membrane, called the *pituitary* or *Schneiderian membrane*, continuous a short distance within the nostrils with the skin of the face, and at the posterior nares with lining membrane of the pharynx. It is continuous also through the nasal and lachrymal ducts with the conjunctiva (the mucous membrane covering the eye), and is prolonged, through the different apertures, into the frontal, ethmoidal, sphenoidal, and maxillary sinuses. It varies in color and thickness at different parts. It is of a bright red color, and very thick upon the turbinate bones, particularly the inferior; somewhat less so upon the septum, and remarkably pale and thin between the turbinate bones and in the several sinuses enumerated above. Its epithelium is squamous or tesselate near the anterior nares, but throughout the remainder of its extent provided with ciliæ. Its attached surface is not in immediate contact with the bones, but is intimately connected with a strong fibro-vascular periosteum, on which account it is sometimes denominated a fibro-mucous membrane.

The *vessels* of the pituitary membrane are very numerous. Its arteries are principally offsets from some of the subdivisions of the internal maxillary; one of them, although not very large, of more practical importance than the others, is the *artery of the septum*, which comes from the spheno-palatine, and descends forward, upon each side of the septum, nearly as far as the anterior nares, and sends branches to all the surrounding parts. The veins form an extended plexus between the mucous and fibrous layers, and communicate principally with the facial and ophthalmic veins; those from the roof of the cavity communicate also, through the cribriform plate of the ethmoid bone, with the veins within the cranial cavity.

The *nerves* are derived from the first and the fifth pairs.

The first or olfactory nerve, the special nerve of the sense of smell, is distributed solely to this membrane. The main trunk of the nerve is contained within the cavity of the cranium, and terminates anteriorly in a bulbous enlargement which rests upon the upper surface of the cribriform plate of the ethmoid bone. From the under surface of the bulb, the numerous branches are derived which traverse the foramina of the cribriform plate, and divide into two sets, one for the septum, and the other for the outer wall of the cavity, which descend between the mucous and fibrous layers in grooves upon the surfaces of the bones, and form an intricate network in the substance of the mucous membrane. The nerves of the septum are somewhat larger than the others, and are distributed as low down as the inferior fourth of this structure, below which point they have not been demonstrated. The branches to the outer wall of the cavity are spent upon the membrane covering the superior and middle turbinate bones and the corresponding meatuses, but cannot be detected upon the inferior turbinate bone or in the inferior meatus.

The nerves derived from the fifth or trigeminal are small offsets from the ophthalmic, spheno-palatine, Vidian, palatine, and inferior dental nerves. They endow the membrane with ordinary sensation.

The three *meatuses* (Fig. 217) or grooves upon the outer wall of each nasal cavity, in its recent state, do not differ very materially

Fig. 217.

The outer wall of the left nasal fossa covered with the pituitary membrane. 1. Frontal bone. 2. Nasal bone. 3. Superior maxillary. 4. Sphenoid. 5. The upper spongy bone. 6. Middle spongy bone. 7. Lower spongy bone. The three meatuses of the nose are seen below the three last-named bones. 8. The opening of the Eustachian tube.

from those found in the skeleton, except that they are somewhat better defined, owing to the greater prominence given to the intervening spongy or turbinate bones by their mucous and fibrous investments.

Some of the *foramina*, communicating with the cavities in their skeleton state, are here entirely closed, and the others are materially lessened in size. Thus, in the *superior meatus*, the openings leading into the posterior ethmoidal cells and sphenoidal sinus are very much narrowed, and the large spheno-palatine foramen entirely closed. In the *middle meatus*, the funnel-shaped entrance leading to the anterior ethmoidal cells, and through them to the frontal sinus, is almost concealed from view by an overhanging fold of the mucous membrane; and, farther back, the opening of the antrum or maxillary sinus is narrowed and partly overhung by a circular fold of the same. In the *inferior meatus*, the terminal opening of the nasal duct is rendered valvular by two projecting folds of the lining mem-

brane, which are intended to prevent the air from passing in this direction; they offer a serious obstacle to the introduction of an instrument into the canal.

The openings of the cribriform plate of the ethmoid bone and the anterior palatine foramina of the dried bones are entirely covered by the lining membrane.

In this examination, the student should also direct his attention to the orifice of the Eustachian tube, situated upon the upper lateral wall of the pharynx, and upon a line with the inferior meatus of the nose.

THE LARYNX.

The larynx is the special organ of voice. It is situated over the commencement of the trachea or windpipe, in the upper forepart of the neck, in front of the lower part of the pharynx, and below the hyoid bone and root of the tongue. It consists of a jointed cartilaginous framework, special muscles for the movement of its several pieces, two peculiar ligaments called the vocal cords, and an inclosed cavity, communicating with the pharynx and trachea, and lined by a mucous membrane.

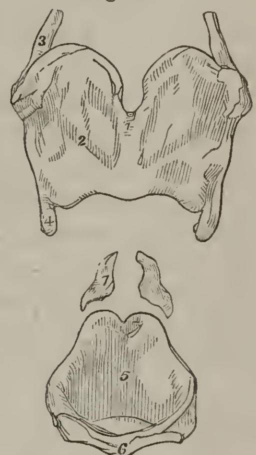
Cartilages of the Larynx.—The number of separate cartilaginous pieces entering into the structure of the larynx is nine, of which six form the skeleton or framework of the organ properly so called, namely, the *thyroid*, *cricoid*, two *arytenoid*, and two little appendages to the arytenoid, called the *cornicula*. The remaining three are the valve, which covers the entrance to the cavity of the organ, and hence called the *epiglottis*, and two minute pieces situated in the adjacent mucous membrane, named from their shape the *cuneiform cartilages*.

The *thyroid cartilage** (Fig. 218, 1), the largest of the set, is symmetrical, and consists of two flaring quadrangular plates or wings (*ala*) united at an acute angle in front, and inclosing a large wedge-shaped space, in which nearly the whole of the other parts of the organ are situated. The anterior edge, formed by the union of the two lateral plates, is more prominent above than below, and lies just beneath the skin, in the middle line of the forepart of the neck above where it

* θυρεός, a shield, and ειδος, like.

forms the projection commonly known as Adam's apple (*pomum Adami*). The *external surface* of each plate is somewhat uneven, and marked near its inferior posterior corner by an indistinct oblique ridge, directed from behind downward and forward, which gives attachment to the sterno-thyroid muscle below and the thyro-hyoid above. The small space below this line gives origin to part of the inferior constrictor of the pharynx, and the larger space above is covered by the sterno-thyroid muscle. The *internal surface* is smooth and concave, and in relation with the other parts presently to be described. The *superior border* is shaped somewhat like the italic letter *s*; it forms, with its opposite fellow, a considerable notch in front, and is connected throughout by a strong fibrous membrane (thyro-hyoid membrane) to the hyoid bone. The *inferior border*, shorter than the superior, and less irregular, is connected in front to the upper edge of the cricoid cartilage by the crico-thyroid membrane, and gives attachment on each side to the crico-thyroid muscle. The *posterior border* is thick and rounded, and prolonged above and below into two considerable processes called the *horns* (*cornua*) of the thyroid cartilage, of which the *superior* is the longer, and connected to the greater horn of the hyoid bone by the thyro-hyoid ligament, and the *inferior* thicker and shorter, and articulated at its extremity with the side of the cricoid cartilage.

Fig. 218.



Cartilages of the larynx separated and seen in front. 1 to 4. Thyroid cartilage. 1. Vertical ridge, commonly called Adam's apple, formed by the union of the two plates or rings. 2. Right ring. 3. Superior, and 4, inferior horn of the right side. 5, 6. Cricoid cartilage. 7. Right arytenoid cartilage.

The *cricoid cartilage* (Fig. 218, 5) is ring-shaped, but, owing to the obliquity of its superior border, is higher behind than in front, measuring nearly an inch in length in the former situation, and only about two lines and a half in the latter. Its anterior narrow surface is subcutaneous in the middle line of the neck below Adam's apple, and upon each gives origin to the crico-thyroid muscle; a little farther removed externally is a small tubercle that articulates with the inferior horn of the thyroid cartilage. The posterior surface is rough, and marked in the middle line by a ridge separating two superficial fossæ that lodge the posterior crico-arytenoid muscles. The superior border is very oblique from behind

downward and forward. In front, it is separated from the lower border of the thyroid cartilage by a transversely oval-shaped interval, occupied by the crico-thyroid membrane; externally, it is crossed by the lower edge of the thyroid cartilage, and gives origin to the lateral crico-arytenoid muscles; behind it is marked by a slight notch, upon the sides of which are two smooth convex facets for articulation with the arytenoid cartilages. The inferior border is rounded and horizontal, and connected to the upper edge of the first ring of the trachea. The interior of the cricoid cartilage is smooth, and lined by a fibro-mucous membrane.

The two *arytenoid cartilages* are irregularly triangular pyramidal in shape, from five to six lines in length, three lines in width, and little more than a line in thickness. They are articulated by their bases to the highest part of the superior border of the cricoid cartilage behind, are parallel, but separated by a narrow interval, and bent a little backward at their tips. The *surfaces* of each are rough for the attachment of muscles; except the internal and narrowest surface, which presents toward its fellow, and is covered only by the mucous membrane. The *base* is slightly excavated, and near its inner part presents a smooth articular facet. The anterior of the angles of the base is very prominent, and gives attachment to the posterior extremity of the vocal cord; the external, short and rounded, gives insertion to the posterior and lateral crico-arytenoid muscles. The apex or summit of each cartilage forms a blunt point, to which is appended the corresponding corniculum.

The *cornicula* are two little cartilaginous nodules appended to the summits of the arytenoid cartilages.

The *cuneiform cartilages* are two very small cartilaginous bodies found in the fold of the mucous membrane, which extends from the summits of the arytenoid cartilages to the sides of the epiglottis.

The *epiglottis* (Fig. 220, 4, and 221, 1) is a thin flexible plate of fibro-cartilage, shaped somewhat like a cordate leaf, the stem or pedicle of which is attached to the retreating angle of the thyroid cartilage. It is situated upon the base of the tongue, to which it is intimately connected by mucous membrane, and, in the quiescent state of the parts, stands vertically upward in front of the superior opening of the larynx. Its anterior surface is convex, and is connected to the surface of the tongue, upon which it rests by three little folds or bridles of mucous membrane, of which the middle is the largest. The posterior surface is free, concave from side to side, and pitted by the orifices of numerous little muciparous fol-

licles. Its superior edge is free, and may sometimes be seen in examinations of the throat, by forcibly depressing the tongue with a spatula. Its lateral edges are connected to the summits of the arytenoid cartilages by two large folds of mucous membrane which pass directly backward, and to the sides of the pharynx by two smaller ones extending transversely outward. The office of the epiglottis is to cover the entrance to the larynx in swallowing, which it does more by the elevation of the latter than by its own depression.

LIGAMENTS OF THE LARYNX.—The thyroid cartilage is connected to the hyoid bone by two ligaments and a broad membrane.

The *thyro-hyoid ligaments* are two rounded fibrous cords, extending from the greater horns of the hyoid bone to the superior horns of the thyroid cartilage.

The *thyro-hyoid membrane* consists of several superimposed fibrous laminæ, attached above to the posterior edge of the hyoid bone, and below to the whole length of the superior border of the thyroid cartilage, and continuous by its lateral borders with the thyro-hyoid ligaments.

The cricoid cartilage is connected to the upper border of the first ring of the trachea by a fibrous membrane, similar to that which connect the rings of this tube to one another, and by the lining mucous membrane.

The ligaments that connect the several pieces of the larynx together—called *intrinsic*, to distinguish them from the preceding, which are *extrinsic*—are numerous, and many of them quite small.

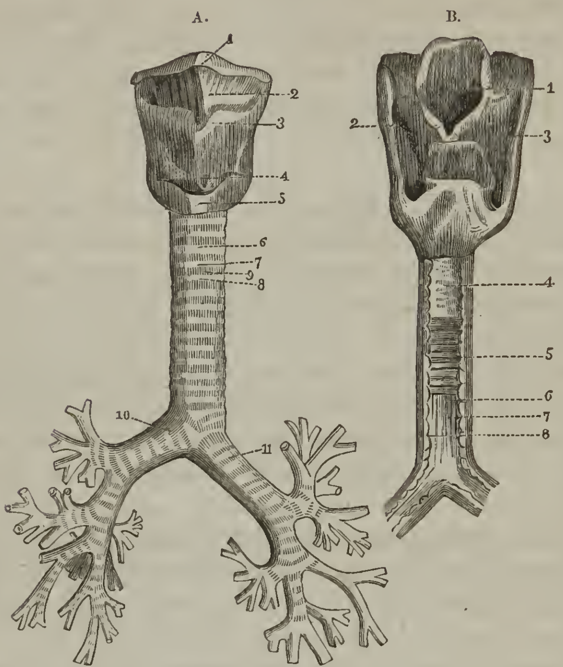
1. The ligaments that connect the cricoid and thyroid cartilages are two capsular and one membranous. The capsular ligaments surround the little diarthrodial articulations that exist between the inferior horns of the thyroid cartilage and the outer surface of the cricoid cartilage. They are lined by a synovial membrane, and are similar in all respects to the capsular ligaments of the skeleton.

The *crico-thyroid membrane* is a strong fibro-elastic lamella, which closes the interval between the thyroid and cricoid cartilages in front. It is transversely oval, and is said to be continuous at its outer extremities with the lower margins of the vocal cords.* This membrane is subcutaneous in front, but covered laterally by the crico-thyroid muscle; it is perforated by minute vascular foramina,

* Quain.

and lined internally by the mucous membrane of the larynx. It is through this membrane that the operation of laryngotomy is performed.

Fig. 219.



A. Larynx, trachea, and bronchial tubes viewed in front. 1. Hyoid bone. 2. Thyro-hyoid membrane. 3. Thyroid cartilage. 4. Crico-thyroid membrane. 5. Cricoid cartilage. 6. Trachea. 7, 8. Two cartilaginous rings. 9. Membrane which separates them. 10. Right bronchus and its divisions. 11. Left bronchus.

B. Larynx, trachea, and commencement of the bronchial tubes, viewed from behind. 1. Upper opening of the larynx. 2, 3. Lateral grooves of the larynx. 4. Fibrous membrane of the trachea, interspersed with small glands, beneath which is seen, 5. The muscular fibres; beneath this last are seen, 6, 7. Small fibrous bands, 8. The mucous membrane seen between them.

Each arytenoid cartilage is articulated to the cricoid by a regular ball and socket joint, having a considerable latitude of motion. The two are united by an imperfect capsular ligament surrounding the joint, and by a small but strong flattened fibrous band, called the *posterior crico-arytenoid ligament*, which is attached by one extremity to the base of the arytenoid cartilage behind, and by the other to the back part of the cricoid cartilage.

The cornicula are articulated to the summits of the arytenoid cartilages by synovial membrane, and a few scattered capsular fibres.

The arytenoid cartilages are connected to the thyroid cartilage by two strong fibrous bands, called the *vocal cords*, which extend from the projecting angles of the bases of the former forward to the retreating angle of the thyroid cartilage. They are sometimes called the *true* vocal cords, to distinguish them from the two thyro-arytenoid folds of the mucous membrane, uniting the same cartilages immediately above, and called the *false* vocal cords. They may be studied in connection with the interior of the larynx, upon a vertical antero-posterior section, and upon an undissected larynx.

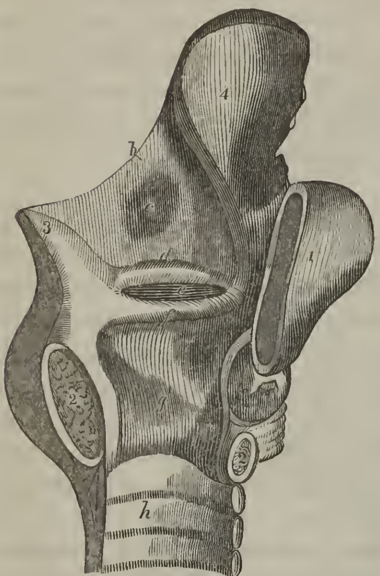
Interior of the Larynx.—The cavity of the larynx is of a peculiar and very irregular form, and cannot, possibly, be understood except by actual examination. It communicates above with the pharynx by a large triangular opening, bounded in front by the epiglottis, and laterally by two large folds of mucous membrane, that stretch from the cornicula and summits of the arytenoid cartilages to the margins of the epiglottis. Within these folds are a few scattered ligamentous and muscular fibres. Below this point the cavity rapidly narrows to the vocal cords, where, by the close apposition of these structures, it is contracted into a mere chink or fissure, somewhat wedge-like or triangular in form, its base presenting backward and its apex forward. The narrow part of the cavity of the larynx, immediately above the true vocal cords, is called the *glottis*,* and the narrow slit between the vocal cords, the *rima* of the glottis. Below the rima the cavity again expands into a transverse oval, and at the lower circumference of the cricoid cartilage is circular.

Upon an antero-posterior vertical section of the larynx, like that represented in Fig. 220, the following structures are met with, commencing above: 1 (*b*), the large aryteno-epiglottidean fold; 2 (*c*), a large oval-shaped surface, interesting as being the principal seat of œdema in acute laryngitis; 3 (*d*), the thyro-arytenoid fold of mucous membrane, called also the superior or false vocal cord, which stretches between the retreating angle of the thyroid cartilage and base of the arytenoid cartilage; 4 (*e*), a long narrow antero-posterior crevice or fissure, leading outward to the cavity called the

* The term glottis is variously employed; some writers apply it to the large triangular opening communicating with the pharynx, and some to the circumference of the cavity at the rima. The author prefers to follow Quain, in limiting its application to the narrow part of the cavity, immediately above the rima.

ventricle of the larynx; 5 (f), the vocal cord properly so called, stretched from the base of the arytenoid cartilage to the retreating angle of the thyroid cartilage; 6 (g), the concave surface of the lateral wall of the cricoid cartilage; 7 (h), the lateral wall of the trachea.

Fig. 220.



View of the interior of the left half of the larynx. 1. Thyroid cartilage, of which most of the right lateral plate has been removed. 2. 2. Cricoid cartilage cut. 3. Left arytenoid cartilage. 4. Epiglottis. *b*. Upper margin of the aryteno-epiglottic fold. *c*. Inner surface of same. *d*. Thyro-arytenoid fold or false vocal cord. *e*. Entrance to the ventricle of the larynx. *f*. True vocal cord. *g*. Inner surface of the cricoid cartilage. *h*. Inner surface of the trachea.

The *vocal cords* (inferior or true vocal cords) are the sounding strings, by which the voice is mainly produced. They consist of parallel fibres of elastic tissue, collected upon each side into a narrow band, which stretches from the prominent, rounded, anterior angle of the base of the arytenoid cartilage horizontally forward, to the middle of the entering angle of the thyroid cartilage. They are covered by mucous membrane, and form upon each side the lower margin of the opening of the ventricle.

The *rima of the glottis* is the narrow chink or cleft between the vocal cords. It is lancet-shaped, its pointed extremity presenting forward, and measures in the adult nearly an inch in length. Its breadth is greatest behind, but varies with the position of the arytenoid cartilages; ordinarily, however, it is about a third of an inch across at its widest part, and may be increased to half an inch.

The *ventricles of the larynx* are the two flattened oblong cavities, one of which is situated upon each side. They lead from the narrow elliptical opening between the true and false vocal cords, in an outward and upward direction. These cavities are comparatively small in the human subject, but very large in some of the inferior animals.

From the anterior part of each ventricle a narrow opening leads to a small conical cavity, called the *laryngeal pouch*, which extends

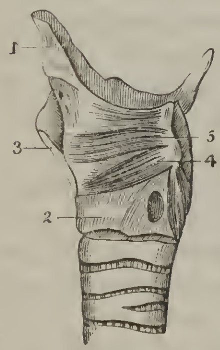
outward beneath the mucous membrane, as far as the superior border of the thyroid cartilage, and forward as far as the lateral margin of the epiglottis. It is lined by a prolongation of the mucous membrane, surrounded by a quantity of adipose tissue, an imperfect fibrous covering, and a few scattered muscular fibres. A large number of little mucous glands communicate with its interior.

Muscles of the Larynx.—The muscles of the larynx are extrinsic and intrinsic; that is, they act upon the organ as a whole, or upon its individual pieces. The former have been already described with the other muscles of the neck; they are the sterno-hyoid, sterno-thyroid, omo-hyoid, thyro-hyoid, stylo-hyoid, &c. The intrinsic consist of four pairs, and a single muscle; those in pairs are the crico-thyroid, posterior crico-arytenoid, lateral crico-arytenoid, and thyro-arytenoid; the single one is the arytenoid.

The *crico-thyroid muscle*, short, thick, and triangular, arises from the anterior surface of the cricoid cartilage, a little external to the median line, ascends obliquely outward along the outer limits of the crico-thyroid membrane, and is inserted into the external third of the lower border of the thyroid cartilage, and into the anterior margin of the inferior horn of the same.

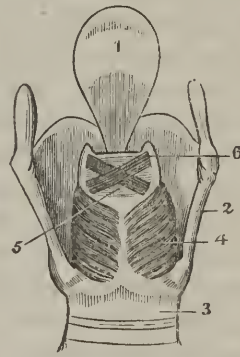
The *posterior crico-arytenoid muscle* (Fig. 222, 4) occupies the superficial depression upon the posterior surface of the cricoid car-

Fig. 221.



Muscles and cartilages of the larynx. 1. Epiglottis. 2. Cricoid cartilage. 3. Thyroid cartilage. 4. Lateral crico-arytenoid muscle. 5. Thyro-arytenoid muscle.

Fig. 222.



Laryngeal muscles, &c. 1. Epiglottis. 2 Thyroid cartilage. 3. Cricoid cartilage. 4. Posterior crico-arytenoid muscle. 5. Transverse arytenoideus muscle.

tilage, by the side of the median ridge. It is flattened, triangular, and of a bright red color. It arises from the whole of the surface

upon which it is situated, ascends, its fibres being converging, and is inserted by a narrow extremity into the base of the arytenoid cartilage behind.

The *lateral crico-arytenoid muscle* (Fig. 221, 4), smaller than the preceding, and of an oblong figure, arises from the upper border of the cricoid cartilage in front, and on the outer side of the crico-arytenoid articulation, ascends obliquely backward, and is inserted into the external and shorter of the two processes of the base of the arytenoid cartilage.

The *thyro-arytenoid muscle* (Fig. 221, 5), broad and thin, arises in front from the lower half or two-thirds of the retreating angle of the thyroid cartilage, passes horizontally backward, below and along the outer border of the vocal cord, and is inserted into the anterior projection of the base, and for a little way along the contiguous outer border of the arytenoid cartilage.

The *arytenoid muscle* (Fig. 222, 5) occupies the narrow interval between the two arytenoid cartilages, and consists of oblique and transverse fibres. It arises from the outer border and posterior surface of the arytenoid cartilage, and is inserted with the corresponding parts of the other.

Besides the nine separate muscles above described, modern anatomists have demonstrated the existence of muscular fascicles in other parts of the larynx. They may be arranged in three groups: 1. *Thyro-epiglottic* fibres, which ascend from the thyro-arytenoid muscles, and are inserted into the lateral margins of the epiglottis. 2. *Superior aryteno-epiglottic* fibres, which extend from the summits of the arytenoid cartilages to the borders of the epiglottis inclosed in the folds of mucous membrane that form the lateral boundaries of the large triangular entrance of the larynx. 3. *Inferior aryteno-epiglottic* fibres, which arise from the arytenoid cartilage immediately above the attachment of the vocal cords, pass forward, spread out upon the upper surface of the laryngeal ventricles and pouches, and are inserted into the lateral margins of the epiglottis. These three sets of fibres cannot always be clearly demonstrated in the human larynx, but are very evident in some of the inferior animals.

Actions.—The actions of the intrinsic laryngeal muscles are complicated, and in some instances obscure. The *crico-thyroid* approximate the two cartilages between which they are placed, and assist in making the vocal cords tense by advancing the thyroid cartilage. The *posterior crico-arytenoid* dilate the rima and the cavity of the organ above, and at the same time tighten the vocal cords. The *lateral crico-arytenoid* rotate the arytenoid

cartilages inward, so as to approximate and tighten the vocal cords. The *thyro-arytenoid* approximate the thyroid and arytenoid cartilages, and rotate the latter inward, thus tightening and approximating the vocal cords, and, at the same time, diminishing the glottis and rima in an antero-posterior direction. The *arytenoid* approximates the arytenoid cartilages and rotates them outward, by which means the vocal cords are at first relaxed and then tightened and separated, whilst the cavity above is diminished transversely. The *thyro-epiglottic fibres* draw down the epiglottis and increase the lateral concavity of its posterior surface. The *superior aryteno-epiglottic* approximate the epiglottis and arytenoid cartilages, and relax the aryteno-epiglottic folds of mucous membrane. The *inferior aryteno-epiglottic* draw the epiglottis backward and downward, and compress the laryngeal ventricles and pouches.

The *mucous membrane* of the larynx is continuous above with that of the mouth and pharynx, and below with that of the trachea. Traced from above, it will be found reflected from the upper surface of the tongue behind to the anterior surface of the epiglottis, forming the three glosso-epiglottic bridles (fræna) and two intervening pouches or depressions already described; it covers the posterior surface of the epiglottis, and from the lateral margins of this organ extends backward to the cornicula and summits of the arytenoid cartilages in the form of two large folds (aryteno-epiglottic or epiglottidean), which form the lateral borders of the entrance to the larynx. Across the summits of the arytenoid cartilages it forms a short crescentic border, which is the posterior limit of the entrance to the superior opening. From these points, it descends into the cavity of the larynx, forming upon each side a large oval fossa, and below this, the thyro-arytenoid fold or false vocal cord. It then lines the laryngeal ventricles and pouches, passes over the true vocal cords, and spreads out upon the inner walls of the cavity below. It is of a pale pink color, varies in thickness at different points, and is covered by a columnar ciliated epithelium. Its attachment to the subjacent parts takes place by means of areolar tissue, which before the age of puberty is short and close throughout, but in the adult becomes loose and open in certain situations, particularly in the oval fossæ beneath the aryteno-epiglottic folds; hence, the greater danger of acute laryngitis in adults from œdema of the glottis. Over the vocal cords the membrane is exceedingly thin and delicate, and most closely adherent.

The laryngeal mucous membrane is largely provided with mucous crypts or glands. They are most abundant upon the epiglottis and in the laryngeal pouches; but are entirely wanting upon the surface and in the immediate neighborhood of the vocal cords.

VESSELS AND NERVES OF THE LARYNX.—The *arteries* of the larynx are small branches of the superior and inferior thyroid arteries. The *veins* follow the course of the arteries. The *nerves* are the two superior and two inferior laryngeal, branches of the pneumogastric, and filaments from the sympathetic. The *superior laryngeal nerve* of each side leaves the pneumogastric just below the base of the cranium, descends forward, enters the larynx through the thyro-hyoid membrane just above the superior border of the thyroid cartilage, and is distributed to the mucous membrane, and to the arytenoid and crico-thyroid muscles. The *inferior* or *recurrent laryngeal nerve* of the right side winds around the subclavian artery, and of the left, around the arch of the aorta; they ascend along the groove formed by the juxtaposition of the trachea and œsophagus, enter the larynx behind, and are distributed to all the muscles except the crico-thyroid.

Changes in the Larynx.—In early life, the larynx is very small and rounded, and does not differ materially in the two sexes. About the age of puberty, however, it undergoes a rapid increase in size, involving in the male a change also in its figure. The increase in the male is about double the original size of the organ, and in the female, about one-third. In the female, the original rotundity of the organ is not altered by its increase in size; but in the male, it becomes more angular, and forms the prominence in the upper part of the neck commonly known as *Adam's apple.*

The student should now proceed to dissect the

DEEP MUSCLES OF THE NECK.

The deep muscles of the neck consist of six pairs. They are the *long cervical muscle*, the *great and small anterior straight muscle of the head*, the *lateral straight muscle of the head*, and the *anterior* and *posterior scalene muscles.*

The LONG CERVICAL MUSCLE (*longus colli*) is long and narrow, and divided below into three fleshy slips. It arises from the bodies of the four lower cervical and three upper dorsal vertebræ, and the anterior tubercles of the transverse processes of the third, fourth, and fifth cervical vertebræ, ascends upon the front of the spine, and is inserted by small tendons into the anterior tubercle of the atlas and the transverse processes of the third and fourth cervical vertebræ.

Use.—To bend the neck laterally, and to assist in rotating the atlas upon the axis; or, if both muscles act, to bend the neck forward.

Relations.—Posteriorly, with the front of the cervical vertebræ, and anteriorly, with the pharynx, œsophagus, internal carotid artery, jugular vein, pneumogastric and great sympathetic nerves.

The GREAT ANTERIOR STRAIGHT MUSCLE OF THE HEAD (*rectus capitis anticus major*), long and flat, arises from the anterior tubercles of the transverse processes of the four lower cervical vertebræ, ascends nearly vertically, and is inserted into the basilar process of the occipital bone.

Use.—To flex the head forward.

Relations.—The same as the preceding.

The SMALL ANTERIOR STRAIGHT MUSCLE OF THE HEAD (*rectus capitis anticus minor*), very short and small, arises from the transverse process of the atlas, and is inserted into the basilar process of the occiput.

Use.—The same as preceding.

The LATERAL STRAIGHT MUSCLE OF THE HEAD (*rectus capitis lateralis*) is very short, and extends from the upper surface of the transverse process of the atlas to the jugular process of the occipital bone.

Use.—To incline the head laterally.

The ANTERIOR SCALENE MUSCLE (already partly described) is situated by the side of the spine in the lower part of the neck. It arises by tendinous slips from the anterior tubercles of the transverse processes of the third, fourth, fifth, and sixth cervical vertebræ, descends a little forward, and is inserted by a narrow flat tendon into a rough surface upon the upper surface of the first rib.

Relations.—Anteriorly, with the diaphragmatic nerve, transverse cervical and posterior scapular arteries, and subclavian vein; posteriorly, with the subclavian artery and brachial plexus of nerves, which separate it from the next muscle.

The POSTERIOR SCALENE MUSCLE, longer and larger than the preceding, arises by tendinous fibres from the posterior tubercles of the transverse processes of the four or five lower cervical vertebræ, descends a little outwards, and divides into two slips, the anterior of

which (sometimes called the middle scalene muscle) is inserted into the upper surface of the first rib behind the groove for the subclavian artery; and the posterior, into the upper edge of the second rib between its tubercle and angle.

Relations.—In front, it is in relation with the brachial plexus of nerves, subclavian artery, and anterior scalene muscle; behind, with the transverse, splenius, and scapular elevator muscles on the back of the neck.

Action.—The scalene muscles bend the neck forward and laterally, and elevate the first and second ribs.

THE THORAX.

ANTERIOR AND LATERAL SURFACES.

The anterior and lateral walls of the thorax are covered by the skin, superficial fascia, great and small pectoral, and great serrate muscles.

One side should be dissected with special reference to the muscles; and the other, to study the contents of the axilla or armpit.

Dissection of the Muscles of the Chest.—Carry the arm from the side, so as to put the pectoral muscles upon the stretch, and then, an incision having been already made along the clavicle to the acromion process in the dissection of the neck, divide the skin in the median line the whole length of the sternum, and along the lower edge of the great pectoral muscle which forms the prominent anterior margin of the armpit, carrying the incision as far as the upper part of the arm. By this means, a triangular flap of skin is marked off, which is to be removed, leaving the fascia on the surface of the muscle. If the subject is a female, one of the breasts may be dissected by making several radiating incisions from the nipple, dissecting off the flaps, and then carefully picking out, and clipping off the little masses of fat and areolar tissue that are generally found between the excretory ducts of the gland. This is much facilitated if the ducts have been previously injected with tallow or wax.

The *thoracic fascia*, although not unfrequently dense and strong, is generally thin and of a loose open texture. It may be separated into two distinct layers, the superficial one of which is continuous with the superficial fascia of the neck, and in the female covers the mammary gland; while the deeper one is closely attached to the clavicle and sternum, passes beneath the mamma, covers the surface of the great pectoral muscle, and is continuous below with the aponeurosis of the external oblique muscle of the abdomen.

THE MAMMARY GLANDS.

The mammary glands (*mammæ*), the organs of lactation in the female, are situated upon each side of the anterior surface of the

chest, between the skin and great pectoral muscles, where, together with a large amount of fat, they form the two large rounded eminences commonly called the breasts. The base of each breast is slightly oval in an oblique direction from below upward and outward, and extends from the outer border of the sternum to the edge of the armpit, and from opposite the third to the seventh rib. A little below the centre of the convexity is the conical projection called the *nipple*, upon the apex of which are fifteen or twenty little foramina leading to the lactiferous ducts. The skin of the nipple is of a dusky brown color, and surrounding its base is a colored circle called the *areola.* In virgins, this areola is of a bright pink or rosy color, but in women who have borne one or more children it has always a brownish hue. In the neighborhood of the areola are numerous sebaceous follicles, which during suckling are very much increased in size; they secrete an oily substance for the protection of the nipple.

STRUCTURE.—The large rounded form of the breasts depends upon the presence of a considerable quantity of yellow, firm, consistent fat, which surrounds and fills up the interstices of the gland. The proper tissue of the organ consists of a collection of irregular masses or lobes, each surrounded by an investment of fibro-areolar

Fig. 223.

Single lactiferous duct, after Sir A. Cooper. 1. Apex of the nipple. 2, 2, 2. Straight lactiferous ducts of the nipple 3. Sac-like dilatation of the ducts at the base of the nipple. 4, 4. Origin of the ducts in the substance of the gland.

tissue, and provided with an excretory duct. The lobes are subdivided by prolongations of the fibrous covering into small lobules, and these consist of minute blind vesicles, which are the terminal extremities of the divisions of the excretory ducts.

From the vesicles the minute canals proceed to form the excretory ducts. These vary from fifteen to twenty in number; they

converge toward the base of the nipple, where they become slightly dilated, and then continue on, separate, but closely connected by areolar tissue, to their minute terminal orifices upon the summit of the organ. The walls of the ducts consist of fibrous tissue, lined by a mucous membrane which is covered by a squamous epithelium, and is continuous with the skin of the nipple. The nipple is covered externally with skin marked by numerous wrinkles, and supplied with sensitive papillæ. Internally, it seems to be made up of firm areolar tissue and a large number of vessels surrounding the lactiferous ducts. It is capable of a certain degree of erection when mechanically excited.

Vessels and Nerves.—The breasts are supplied with *arteries* from the intercostals, internal mammary, and thoracic branch of the axillary. Its *veins* correspond to the arteries. Its nerves are derived from the cutaneous branches of the intercostals.

In the male, the mammary glands are perfect in all their parts, but are only rudimentary, although capable, under continued and often repeated mechanical excitement, of as perfect development as in the female.

DISSECTION.—Remove the mammary glands and the subjacent fascia, directing the edge of the knife as usual in the course of the muscular fibres underneath.

The GREAT PECTORAL MUSCLE (Fig. 131, 1), large, flat, and irregularly triangular, covers nearly the whole of the anterior superior part of the chest. It arises from the anterior border of the sternal half of the clavicle; from the anterior surface of the sternum, for three-fourths of its extent, its fibres indigitating here with those of its fellow of the opposite side; from the cartilages of the third, fourth, fifth, and sixth ribs; and by a thin fleshy slip from the aponeurosis of the external oblique muscle of the abdomen. From these points the fibres converge in front of the armpit, and are inserted by a flattened tendon, somewhat more than an inch in breadth, into the anterior or external margin of the bicipital groove of the humerus. That portion of the muscle originating from the clavicle is generally separated from the sternal portion by a narrow areolar interval, and lies parallel to and in close connection with the anterior edge of the deltoid muscle, except near the clavicle, where a small triangular space intervenes. The cephalic vein generally occupies the line of separation between the two muscles, and dips into the triangular interval to reach the axillary vein. The costal portion ascends obliquely beneath the sternal, giving to the lower margin of the muscle, where it forms the anterior edge of the axilla,

a twisted appearance; it is continuous with the upper part of the tendon of insertion, which in consequence presents a crucial arrangement of fibres.

Relations.—The great pectoral is covered throughout by the skin and thoracic fascia, a small portion of the platysma muscle intervening above, and is overlapped slightly at its insertion by the anterior edge of the deltoid. It conceals from view the small pectoral and subclavian muscles, and the numerous structures contained in the axillary cavity.

Use.—When the thorax is the fixed point, and the arm is partly elevated, the united action of all the fibres of the muscle tends to carry the arm forward; but the clavicular portion acting with the deltoid would also raise it, and the costal portion depress it. When the arm is raised and fixed, the muscle assists in dilating the chest or raising the body.

Dissection.—Detach the great pectoral from its origin, reflect it outward, and remove the fascia from the surface of the subjacent muscle.

The small pectoral muscle (*pectoralis minor*) (Fig. 131, 6), long, flat, and somewhat triangular, arises from the third, fourth, and fifth ribs external to their cartilages, ascends obliquely outward in front of the axilla, and is inserted by short tendinous fibres into the inner side of the extremity of the coracoid process of the scapula.

Relations.—In front, it is in relation with the great pectoral, the superior thoracic vessels crossing between; and behind, with the axillary vessels and nerves. It is also covered at its insertion by the deltoid muscle.

Use.—To draw the shoulder downward and forward, or, where the scapula is the fixed point, to elevate the ribs.

The subclavian muscle (Fig. 131, 5), although belonging as much to the neck as to the chest, is best seen in this dissection. As its name indicates, it is situated beneath the clavicle, and is covered in front by a dense strong fascia, which must be detached from the clavicle and the first rib, before the muscle can be properly studied. It originates from the cartilage of the first rib by a thick round tendon, passes upward and outward, spreads out, and is inserted by fleshy fibres along the under surface of the clavicle nearly as far as the acromion.

Relations.—Above, with the clavicle; below, with the subclavian vessels and brachial nerves; and in front, with the great pectoral

muscle, from which it is separated by the above-mentioned aponeurotic layer.

USE.—To depress the shoulder or elevate the chest, according as the rib or clavicle is the fixed point.

DISSECTION.—Remove the small pectoral, and disarticulate the sternal extremity of the clavicle, so as to turn the scapular outward, and thus expose the whole of the succeeding muscle. Next dissect off the remaining skin and fascia from the side of the thorax.

The GREAT SERRATE MUSCLE (*serratus magnus*) is broad and flat, and covers almost the whole of the side of the chest. It arises from the nine superior ribs, except the first, a short distance from their cartilages by as many fleshy slips, of which the lower five or six (Fig. 131, 4) indigitate with the heads of the external oblique muscle of the abdomen; the superior three are covered by the great and small pectoral. From these points the muscle curves outward and backward upon the side of the chest, becoming narrower in consequence of the obliquity of its lowermost fibres, and is inserted into the whole length of the inner lip of the posterior edge of the scapula.

RELATIONS.—By its superficial surface, it is in relation superiorly, with the axillary vessels and nerves, anteriorly, with the under surface of the pectoral muscles, inferiorly, with the latissimus muscle of the back, and posteriorly, with the subscapular muscle which fills up the subscapular fossa; its deep surface is in close contact with the ribs and external intercostal muscles.

USE.—1, to draw the scapula downward and forward; 2, if only the lower fibres act, to throw the shoulder back by drawing the point of the scapula forward; and 3, when the scapula is the fixed point, to dilate the chest, or draw the trunk upward and backward. Its action as a respiratory muscle in dilating the thorax is sometimes very powerful, and is particularly well seen in croup and some other instances of difficult respiration, in which the individual is often observed to brace himself against the side of the bed in order to make the shoulder the fixed point for the action of this as well as the pectoral and latissimus muscles.

The INTERCOSTAL MUSCLES, also partly exposed by the removal of the pectorals, may be more satisfactorily seen by dissecting up the anterior portion of the great serrate. As their name implies, they occupy the intervals between the ribs, and are considered as consisting of two sets, an external or superficial, and an internal or deep. The *external* intercostals arise by fleshy and tendinous fibres

from the external lip of the lower border of each rib, descend obliquely forward, and are inserted into the upper border of the rib below. They extend in a horizontal direction from the transverse processes of the dorsal vertebræ to within a short distance of the costal cartilages, the anterior deficiency being made up by an aponeurosis which is prolonged as far as the sternum. The *internal* intercostals may be seen by removal of the preceding, beneath which they are situated, or, better, after the removal of the lungs, by tearing off the costal pleura. They originate from the internal lip of the lower border of each rib, and are inserted into the inner edge of the border of the rib below; these fibres cross those of the external set from above downward and backward, and each muscle extends in a horizontal direction from the sternum to the angles of the ribs.

Relations.—The external intercostals are in relation externally with the several muscles that cover the surface of the chest, and internally with the internal set, the intercostal vessels and nerves intervening, and, beyond, the angles of the ribs with the pleura lining the chest. The internal set are covered internally by the pleura, externally by the preceding set and their aponeurotic continuations in front, the above-mentioned vessels and nerves intervening.

Use.—To approximate the ribs, by which action, the sternum and first rib being fixed, the chest is dilated.

Having completed the dissection of the muscles on one side, the student should turn to the opposite for the purpose of studying the

AXILLA, OR ARMPIT.

Dissection.—Turn the subject upon the opposite side, fix the arm out at a right angle with the body, and from its anterior upper part make two incisions, one running along the prominent posterior margin of the axilla downward and backward, and the other along the anterior border downward and forward. The triangular flap of skin thus marked off should next be dissected down, and the loose areolar and adipose tissue, lymphatic glands, and small veins (which are very numerous) carefully removed. Great care and an abundant stock of patience are required for the proper performance of this dissection, and as it is a region in which surgical operations are not unfrequently necessary, the student should not negligently slur it over.

The *axillary lymphatic glands*, necessarily removed along with the areolar and adipose tissues, are numerous, and some of them are often quite large. They receive the lymphatic vessels of the upper extremity, and are frequently the seat of inflammatory action, both acute and chronic.

The axilla is a triangular, pyramidal space, bounded *in front* by the two pectoral muscles, *posteriorly* by the latissimus and greater teres muscles on their way to the upper part of the humerus,

and *internally* by the side of the thorax, covered by the great serrate muscle. The apex of the cavity corresponds to the shoulder-joint, and the base is the large triangular opening formed by the lower margins of its lateral walls. Its contents are, the axillary artery and vein with their numerous branches, the axillary or brachial nerves, numerous lymphatic glands, and a large quantity of loose areolar and adipose tissues.

The AXILLARY ARTERY is the continuation of the subclavian, and extends from over the first rib to the outer border of the posterior boundary of the axilla, where it becomes the brachial or humeral artery. Its direction depends upon the position of the arm, being curved upward and outward when the limb is elevated, horizontal, when extended at right angles, and curved downward, when the arm is hanging by the side.

RELATIONS.—As the artery enters the axilla, it is situated below the outer portion of the clavicle and subclavian muscle, external to the subclavian vein, and internal to the great plexus of nerves; and is crossed by the cephalic vein, as this vessel curves downward through the triangular space between the deltoid and great pectoral muscles to open into the axillary vein. About the middle of the cavity, however, the large vein is placed nearly in front, while the axillary plexus disposes itself around the artery so as almost to conceal it from view.

The AXILLARY PLEXUS OF NERVES is the continuation of the brachial plexus, and is at first entirely on the outer side of the artery; but about the middle of the cavity it divides into six main trunks, which are placed as follows: Two large roots, one from the inner and the other from the posterior side of the artery, unite across this vessel to form the *median nerve*, which is at first placed somewhat upon its outer side, but as it descends gradually gains its front, and in the lower part of the arm, as will be hereafter seen, is situated upon its inner side. Behind the artery the *musculo-spinal* or *radial nerve*, nearly if not quite as large as the median, descends toward the back of the arm, and the *circumflex* curves beneath the neck of the humerus; upon the inner side lie the *ulnar* and the *internal cutaneous* nerves, the latter the smallest of the group, both of which descend along the inner part of the arm; upon the outer side the *external cutaneous* nerve passes off toward the external border of the arm.

The AXILLARY VEIN has the same general direction as the artery, in front of and upon the inner side of which it is situated, resting below upon a strong aponeurotic membrane, called, from its attachment, the *costo-coracoid*. The veins that open into it are numerous; thus, it receives below, and, in fact, is the continuation of the two accompanying veins of the brachial artery; a little higher up it receives the basilic; near its upper extremity, the cephalic; and, at different parts of its course, the several veins that accompany the branches of the axillary artery.

The *branches of the axillary artery* are subject to great variation, but, as a general rule, the number of the principal ones is five. They are the—

Acromio-thoracic,
Inferior thoracic,
Subscapular,
Anterior circumflex, and
Posterior circumflex.

The *acromio-thoracic artery*, the common trunk of the acromial and superior thoracic, arises from the anterior aspect of the artery immediately beyond the first rib, ascends over the superior or inner border of the small pectoral muscle, and divides into the acromial and superior thoracic. The *acromial* passes outward over the anterior surface of the small pectoral muscle, and is distributed to the deltoid muscle and other structures about the top of the shoulder. The *superior thoracic* descends between the two pectoral muscles, to which it is distributed.

The *inferior or long thoracic artery* comes off near the middle of the axillary artery, descends along the inferior or outer border of the small pectoral muscle and upon the posterior surface of the great pectoral, to both of which, to the mammæ, and to the side of the thorax, it is severally distributed.

The *subscapular artery*, the largest of the branches of the axillary, arises from the lower aspect of this vessel, opposite the anterior border of the scapula, beneath which it descends in company with the subscapular nerve, and divides into a thoracic and scapular branch. The *thoracic* division passes downward and outward, and is distributed to the great serrate and some of the muscles of the back; the *scapular* portion sends off a large branch (dorsal branch) which turns over to the muscles on the back of the scapula, while the main trunk continues on toward the lower angle of the bone, where it anastomoses with the long thoracic and posterior scapular—a branch of the subclavian. In its course it sends branches to the small and large teres or round muscles, and particularly to the subscapular muscle.

The *anterior circumflex artery*, the smaller of the two, arises just below the preceding, winds around the anterior aspect of the neck of the humerus, lying under the origins of the coraco-brachial and biceps muscles, and is distributed to the muscles and ligaments about the shoulder-joint.

The *posterior circumflex artery*, a vessel of considerable size, arises nearly opposite the subscapular, passes backward and then outward, close under the neck of the humerus, accompanied by the circumflex nerve, and is distributed to all the adjacent structures, particularly to the deltoid muscle.

Branches of the Axillary Plexus of Nerves.—Besides the six main divisions above-mentioned, the axillary plexus gives off branches to the side of the thorax and under part of the scapula. The thoracic branches, called the

anterior thoracic nerves, two in number, supply the two pectoral muscles. The *subscapular nerves,* three in number, descend beneath the inner border of the scapula, are distributed respectively to the subscapular, small teres, and latissimus muscles.

Axillary Intercostal Nerves.—In the dissection of the axilla numerous muscular and cutaneous branches of the intercostal nerves are encountered, the most interesting one of which, called the *intercosto-humeral,* is a branch of the second dorsal nerve; it perforates the great serrate muscle, crosses the axillary space, and ramifies beneath the skin of the upper back part of the arm, anastomosing here with the internal cutaneous, a branch of the axillary plexus.

THE CAVITY AND CONTENTS OF THE THORAX.

DISSECTION.—Divide the costal cartilages on each side, where they join their respective ribs (taking care not to carry the scalpel so deep as to cut the lungs or heart), and disarticulate the sternal extremities of the clavicles. Next raise the lower extremity of the sternum and dissect off the sternal attachment of the diaphragm, and the bone will be held only by the membranous septum, called the anterior mediastinum, which is attached to the whole length of its under surface, separating the two sides of the cavity of the chest, and must also be divided.

The sternum having been thus removed, the serous membrane should be dissected from its under surface, so as to expose the triangular muscle and internal mammary vessels.

The TRIANGULAR STERNAL MUSCLE (*triangularis sterni*), very thin and triangular, arises upon each side, from the under surface of the ensiform cartilage and adjacent portion of the sternum, ascends outward, and is inserted into the third, fourth, fifth, and sixth costal cartilages, by as many thin tendinous and fleshy slips.

RELATIONS.—It is covered underneath by the pleura, which separates it from the fibrous sac of the heart, and is in contact by its opposite surface with the ensiform cartilage, sternum costal cartilages, and internal mammary vessels.

USE.—To depress the cartilaginous extremities of the ribs, and thus assist in expiration.

The *internal mammary artery* is a branch of the first portion of the subclavian. From its origin it descends at first a little forward behind the inner extremity of the clavicle, to reach the posterior surface of the cartilage of the first rib, and then almost vertically behind the costal cartilages, about a quarter of an inch from the border of the sternum, as far as the sixth rib, when it divides into two branches. In its course, it lies between two accompanying veins, and is covered posteriorly by the pleura and triangular muscle. Of its two terminal branches, one runs outward along

the border of the thorax, and the other out upon the anterior abdominal wall, anastomosing with the epigastric.

The two *internal mammary veins* accompany the artery, unite above in a common trunk, and terminate, the left in the left innominate vein, and the right in the superior cava.

Position of the Thoracic Viscera.—Turning now to the interior of the thorax, it will be observed that the middle of the cavity is occupied in a great measure by the heart, contained within the pericardium, and by the great vessels that communicate with this organ. Upon each side are the lungs, which, if perfectly healthy, and unattached by morbid adhesions to the surrounding parts, will be found in a collapsed condition; before the chest is opened, however, they not only entirely fill the lateral spaces, but extend also nearly to the median line in front, overlapping the heart, so as to leave only about one or two square inches of its anterior surface uncovered. The collapsed state, in which they are ordinarily seen, is owing to the admission of air into the chest, as may be proved by putting a ligature upon the trachea previous to dividing the costal cartilages; or, better, by opening the cavity under water.

The Pleuræ.—Interposed between the exterior of each lung and the surrounding parts is a large serous sac, called the pleura, the office of which is to furnish a smooth surface for the parts to move freely upon one another in respiration. As there are two lungs, there are, of course, two pleuræ; which, like all other structures of the same class, are shut sacs, and consist each of a visceral and parietal portion, the former covering the contained organs, and the latter lining the parietes or walls of the cavity. The parietal portion lines the ribs, costal cartilages, and intercostal muscles, constituting what is denominated the *costal* pleura, and also the upper surface of the diaphragm, where it is known as the *diaphragmatic* pleura. From the ribs posteriorly the membrane passes over the sides of the dorsal vertebra, and thence directly forward to the root of the lung, forming, where it stretches between these last two points, one layer of the posterior mediastinum, the pleura of the opposite side forming the other layer in the same manner. Continued from the root of the lung behind, the membrane invests the whole of the free surface of the lung around to the front of the root, constituting what is called the *pulmonic* pleura; thence it is continued upon the exterior of the pericardium to its anterior aspect, where, meeting with its fellow of the opposite side, it stretches for-

ward to the under surface of the sternum and costal cartilages, to form the anterior mediastinum.

The connection between the pleura and the parts which it invests is a close areolar tissue, which, upon the interior of the walls of the chest, is so condensed as to constitute a proper fibrous membrane; this being involved in inflammation of the serous membrane, is said to explain the acute pain attendant upon this disease.

The Mediastina.—The lungs are separated from each other, *in front*, by the reflection of the two pleuræ from the under surface of the sternum to the anterior surface of the pericardium, the two membranes forming here a kind of septum, called the *anterior mediastinum*. *In the middle*, the lungs are divided by the heart and great vessels, which are said, therefore, to occupy the middle mediastinum; and *behind*, by the reflection of the serous membranes from the sides of the vertebra to the roots of the lungs, inclosing the œsophagus, thoracic, aorta, pneumogastric nerves, and several other structures, and denominated the *posterior mediastinum*. The space above the heart which is occupied by the great vessels, and communicates with the anterior and posterior mediastina, is sometimes called the *superior mediastinum*.

The *anterior mediastinum* is not placed precisely in the median line, but inclines below to the left side. In the greater part of its extent it is very narrow, the two pleuræ being nearly in apposition; but superiorly the two laminæ separate from each other, and inclose a narrow triangular space, occupied by the origins of the sterno-hyoid and thyroid muscles, and in the fœtus by the thymus gland, which is usually converted in the adult into areolar adipose tissue, of a dark brown color.

The *middle mediastinum*, improperly so called, is the large space occupied by the heart and the origins and terminations of the great vessels. The latter* should be now dissected; but before commencing the dissection, the student should examine Fig. 224, in order to obtain some idea of the structures to be looked for.

Dissection.—Dissect the pleura from the upper part of the pericardium and the roots of the superior cava vein and aorta, and remove all the intervening cellular tissue.

The first vessel encountered in making this dissection is the LEFT

* The contents of the posterior mediastinum will be seen after the removal of the lungs and heart.

BRACHIO-CEPHALIC OR INNOMINATE VEIN (Fig. 224, *g*), formed by the union of the left jugular and subclavian veins, which takes place just behind the left sterno-clavicular articulation. From its commencement it passes somewhat obliquely across to the right side, where it joins its fellow to form the superior cava. In its course it lies immediately behind the upper margin of the sternum (rising somewhat above this bone, when the head is thrown far back), in front of the innominate and left carotid arteries and the trachea, and just above the highest point of the arch of the aorta. Immediately at the junction of the jugular and subclavian veins, by which it is formed, it receives behind the termination of the thoracic duct, which may be seen by dividing the jugular, turning it down, and making a very careful search.

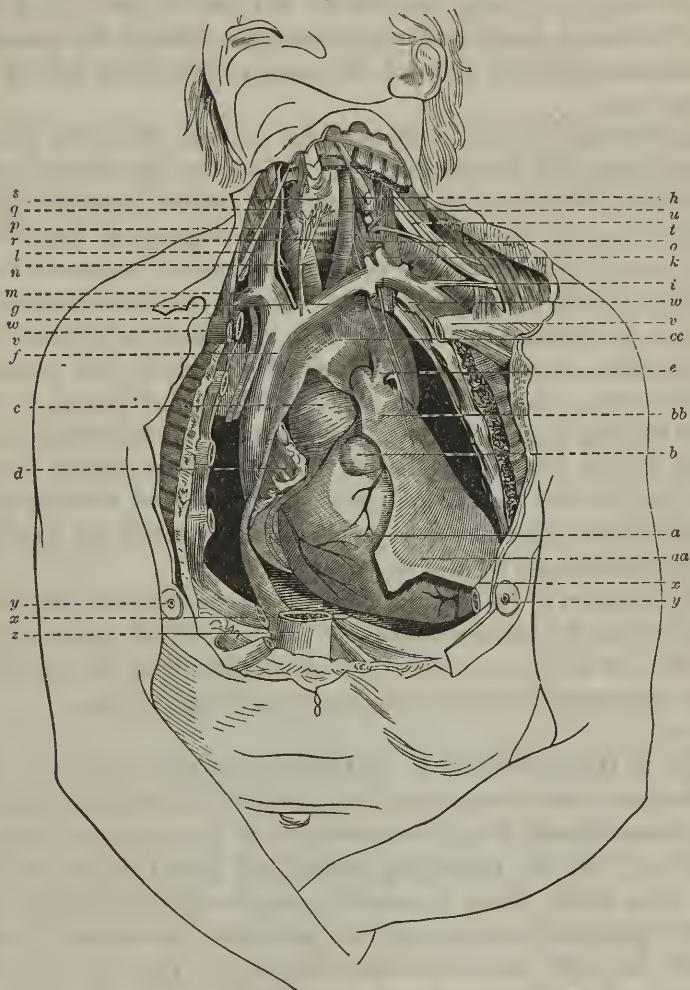
The RIGHT BRACHIO-CEPHALIC OR INNOMINATE VEIN, formed by the confluence of the right jugular (*l*) and subclavian (*m*) veins, is not more than a fourth as long as the left; it passes almost vertically downward, lying in front of and a little to the right of the innominate artery, and unites with the left, behind and a little below the cartilage of the first rib of the right side.

The SUPERIOR OR DESCENDING CAVA (Fig. 224, *f*), formed by the union of the two innominate veins, returns the venous blood from the superior extremities, head, neck, and back of the thorax, to the right side of the heart. It is not more than two or three inches long, but very large, descends almost vertically from its commencement, enters the pericardium about an inch from its termination, and opens into the right auricle of the heart. Before entering the pericardium, it is covered upon its right side by the pleura, and is in contact with the border of the corresponding lung, which is slightly grooved for its reception. Internally, it is in relation with the ascending portion of the aorta, and behind with the trachea, from which, however, it is separated by some of the bronchial lymphatic glands, recognized by their black color. It is also in contact with the right diaphragmatic nerve, which curves around its external surface to reach the side of the pericardium. It receives posteriorly the great azygos vein which collects the blood from the walls of the thorax, curves over the root of the right lung, and opens into the cava just before this vessel becomes covered by the pericardium.

The THORACIC AORTA (Fig. 224, *c c*). To the left of the superior cava vein, the aorta, the main stem of the whole arterial system,

ascends through the pericardium, and makes a curve of at least two-thirds of a circle, denominated the *arch of the aorta.* Before it can be properly studied, the pericardium should be slit open for the length of two or three inches in order to expose the portion con-

Fig. 224.



a. Right ventricle of the heart. *a, a,* and *b, b.* Pericardium. *b.* Pulmonary artery. *c, c.* Arch of aorta. *d.* Right auricle. *e.* Fibrous remains of the arterial duct, through which the pulmonary artery of the fœtus communicates with the aorta. *f.* Superior cava. *g.* Left brachio-cephalic vein. *h.* Left common carotid artery. *k.* Lower end of the left internal jugular vein. *l.* Right jugular. *m.* Right subclavian vein. *n.* Innominate or brachio-cephalic artery. *o.* Left subclavian artery. *p.* Right subclavian artery crossed by the pneumogastric nerve. *q.* Right common carotid. *r.* Trachea. *s.* Thyroid body. *t.* Brachial plexus of nerves. *u.* Upper end of left internal jugular vein. *v, v.* Clavicles cut across and displaced downward. *x, x.* Fifth ribs cut across. *y, y.* Right and left breasts. *z.* Lower end of the sternum.

tained within this sac. It will now be there seen that, after leaving the base of the heart, it at first ascends forward and a little to the right side for the distance of about two inches; it then curves backward and toward the left over the root of the left lung, the highest point of the curve being about an inch below the level of the top of the sternum; and having reached the left side of the body of the third or fourth dorsal vertebra, it descends through the posterior mediastinum, lying in front of the spine a little to the left of the median line.

Relations.—The first portion of the arch of the aorta is contained within the pericardium, and covered by the lining serous membrane of this sac; it is in immediate contact, upon the right, with the superior cava vein, and is crossed obliquely by the pulmonary artery which starts from the heart in front of the root of the aorta, but turns immediately to the left and somewhat backward. Beyond the pericardium it is covered in front and on the left side by the pleura, and crossed by the left diaphragmatic and pneumogastric nerves, the recurrent or inferior laryngeal branch of the latter winding beneath the arch, and ascending across its right side; above, it is in contact with the left innominate vein, behind and to the right, with the trachea and œsophagus, and below, with the right branch of the pulmonary artery. Its relations within the posterior mediastinum cannot be seen at present.

The *branches of the aorta* seen in this dissection are the three large trunks, the brachio-cephalic or innominate, left common carotid, and left subclavian arteries, which originate from the top of the arch, and supply the head, neck, and superior extremities.

The brachio-cephalic or innominate artery (Fig. 224, *n*), the largest of the three, arises from the arch of the aorta, just at the commencement of the horizontal part of its curve, upon a plane anterior to the two succeeding vessels, and nearly in the median line of the body. From its origin it ascends a little backward and to the right, and, having gained the right side of the trachea, divides behind the right sterno-clavicular articulation into the primitive carotid and subclavian of the corresponding side. It measures, therefore, only about an inch or an inch and a quarter in length. It is in relation, in front, with the left innominate vein, which crosses it at right angles, and separates it from the origins of the sterno-hyoid and thyroid muscles upon the posterior surface of the upper part of the sternum; behind, with the trachea, which it crosses

obliquely; on the right, with the pleura that separates it from the border of the corresponding lung; and, on the left, with the thyroid plexus of veins, and a quantity of areolar adipose tissue filling up the triangular interval in front of the trachea, formed by the divergence of this and the left primitive carotid arteries. When the head is thrown far back, the innominate, where it crosses the front of the trachea, rises upon a level with the sternum, and sometimes a little above it, and is in some danger of being wounded in tracheotomy.

The LEFT PRIMITIVE or COMMON CAROTID ARTERY arises immediately to the left and a little behind the preceding, ascends at first somewhat outward, and then vertically along the left side of the trachea to the neck, where it has been already seen. Within the chest it is in relation, in front, with the commencement of the left innominate vein; externally, with the pleura and pneumogastric nerve; internally, with the trachea; and behind, with the thoracic portion of the left subclavian artery.

The LEFT SUBCLAVIAN ARTERY arises from the arch of the aorta, just beyond and behind the left carotid, ascends for the distance of nearly an inch vertically upward, then curves outwardly over the front of the apex of the left lung to reach the root of the neck. It is in relation, in front, with the left carotid artery and subclavian vein; internally, with the pneumogastric and diaphragmatic nerves; behind, with the spine; and externally, with the left layer of the anterior mediastinum.

Peculiarities in regard to the position of the arch of the aorta and the arrangement of its vessels, although very various, are not of frequent occurrence. The top of the arch is generally situated about an inch below the upper margin of the sternum, sometimes just upon a level with it, and in a fewer number of cases an inch and a half below. Sometimes, but very rarely, the arch turns over the root of the right lung instead of the left.

Peculiarities in the origins of the branches of the arch are more common, especially the one in which the left primitive carotid arises from the innominate, but still, none of them are of sufficient frequency to deserve a description in an elementary work. In fact, in an examination of three or four hundred bodies, the author has met with only the variety above mentioned, and this but three times.

The *diaphragmatic* or *phrenic* nerves, also seen in this dissection, descend vertically into the thorax, the *left* along the inner side of the left subclavian artery and over the arch of the aorta, and the *right* over the right subclavian artery, and then upon the outer side of the superior cava vein. They then become applied to the corre-

sponding sides of the pericardium by the reflection of the pleura in front of the roots of the lungs, and having in this manner reached the diaphragm, they spread out into its substance. Each nerve is accompanied in its course along the pericardium by a very small artery called the superior phrenic (a branch of the internal mammary), and by a corresponding vein.

The *pneumogastric nerve* of the right side may here be observed entering the chest between the subclavian vein and artery, whence it passes behind the left innominate and superior cava veins to the side of the œsophagus, with which it may be seen in the dissection of the posterior mediastinum. The *left* descends between the corresponding carotid and subclavian arteries, crosses the arch of the aorta, sending its recurrent branch around this vessel, and enters the posterior mediastinum.

Removal of the Lungs and Heart.—The trachea and œsophagus having been already cut across a short distance below the cricoid cartilage, the carotid and subclavian arteries, jugular and subclavian veins, pneumogastric and diaphragmatic nerves should be divided in the root of the neck; next, turn first one lung and then the other to the opposite side, and divide the pleura and intercostal vessels close along the side of the spine. If the trachea and œsophagus are now taken hold of above, and drawn forcibly downward, no farther use of the knife will be required except to divide the aorta and inferior cava vein where they pass through the diaphragm. If there are any pleuritic adhesions, these will of course have to be first dissected loose before anything can be done.

The lungs and heart having been thus removed, the student should examine the thoracic cavity with reference to its size and shape, and the character of its internal surface, and also dissect out the thoracic portion of the sympathetic nerve, and some of the anterior divisions of the dorsal spinal nerves that accompany the intercostal arteries. When this is done, let him wash the lungs and proceed to a careful dissection of the parts contained in the posterior mediastinum.

The *cavity of the thorax* differs very greatly in *size* in different individuals, but as a general rule bears a very close relation to the general development of the muscular system; it is therefore smaller in the female than in the male, and in persons who lead an inactive life than in those accustomed to much bodily exercise. It is conoidal in shape, flattened from before backward, and encroached upon in the middle line behind by the bodies of the dorsal vertebræ. Its greatest horizontal diameter is the transverse, and the antero-posterior the shortest; but, measured a little to one side of the median line, the antero-posterior diameter is often nearly as great as the transverse, owing to the deep concavity upon each side of the spine formed by the backward curvature of the ribs in this situation. Its

base is not represented by the plane of the lower margin of the cavity in its skeleton state, but corresponds to the superior surface of the diaphragm, the convexity of which upon the right side reaches to a level with the lower border of the fourth rib, and upon the left to that of the fifth. Its *apex* is not truncated, as might be inferred from an examination of the skeleton, but is prolonged on each side behind the scalene muscles about two inches above the first rib, the space between being occupied by the trachea, œsophagus, and great vessels destined for the head, neck, and superior extremities. Its *inner surface* is rendered smooth by the parietal or costal layer of the pleura, which is reflected forward from the sides of the bodies of the dorsal vertebræ, and backward from the under surface of the sternum, to constitute the posterior and anterior mediastina. Beneath, or rather exterior to this lining serous membrane, are the inner surfaces of the ribs, costal cartilages, sternum, and internal intercostal muscles forming the walls of the cavity to which it is adherent by a layer of condensed areolar tissue called the *subpleural aponeurosis.*

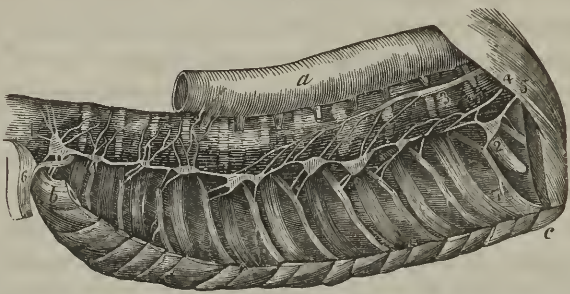
Dissect the parietal pleura from either side of the spine, and the sympathetic nerve will be brought into view.

The *thoracic sympathetic nerve* (Fig. 225) is continuous with the cervical and abdominal portions already described, and lies along the line of the heads of the ribs, opposite each of which it presents a small enlargement or ganglion. From these twelve ganglia, filaments are sent to the intercostal spinal nerves, to the several thoracic viscera, and to some of the plexuses of the abdomen. The last-named branches are the three splanchnic nerves, distinguished from each other as the great, small, and smallest. The *great splanchnic nerve* (Fig. 225, 3) is a cord of considerable size formed by the union of filaments from the seventh, eighth, ninth, and tenth thoracic ganglia; it descends inwards, and perforates the corresponding pillar of the diaphragm to enter the abdomen, and terminates in the semilunar ganglion. Although apparently an offset from the sympathetic, it is in a great measure composed of spinal fibres, which the ganglia receive from the dorsal nerves. The *small splanchnic nerve* (4) is derived from the tenth and eleventh ganglia, descends through the diaphragm near the spine, and terminates in the cœliac plexus. The *smallest* or *third splanchnic nerve* (5), a mere twig, comes from the twelfth ganglion, perforates the diaphragm near by, and joins the renal plexus.

Dissect the costal pleura and the internal intercostal muscles from one side of the chest, and the intercostal nerves, arteries, and veins will be exposed.

The INTERCOSTAL NERVES (represented in Fig. 225 receiving filaments from the sympathetic ganglia) are the anterior divisions of

Fig. 225.



A representation of the ganglia of the sympathetic in the chest (the ganglia are represented larger than natural). The wood-cut is taken from part of a plate in Mr. Swan's work. *a*. Aorta. *b*. First rib. *c*. Eleventh rib. 1. First thoracic ganglion. 2. Last thoracic ganglion. 3. Large splanchnic nerve. 4. Small splanchnic nerve. 5. Smallest splanchnic nerve. 6. Part of the brachial plexus.

the dorsal spinal nerves, and correspond in number to the ribs. The *first* of the twelve joins the bronchial plexus, and sends off a small branch that runs along the first intercostal space, and is distributed principally to the corresponding internal and external intercostal muscle, between which it is placed. The *second* follows the corresponding intercostal space between the two muscles, and is remarkable for its large cutaneous branch, called the *intercosto-humeral*, which crosses the axilla to be distributed to the skin of the upper back part of the arm. The *nine* succeeding intercostals accompany the arteries of the same name; the superior reach as far forward as the sternum, near which they divide up into cutaneous branches (anterior cutaneous nerves of the thorax); the inferior are continued forward across the lower margin of the thorax and between the internal oblique and transverse abdominal muscles, to the straight muscle and the integument near the median line of the abdomen. The *twelfth* intercostal nerve is situated below the twelfth rib, crosses the front of the square lumbar muscle obliquely from within outward and downward, perforates the lumbar origin of the transverse muscle, and then, running a short distance between this and the internal oblique muscle, pierces the latter and the external oblique above the iliac crest to reach the skin over the outer upper part of the hip.

The INTERCOSTAL ARTERIES, ten in number on each side, are all branches of the aorta except the first two, which come from the subclavian. From their origin, they curve around the bodies of the dorsal vertebræ to reach the middle of the intercostal spaces, and then ascend obliquely, lying between the internal and external intercostal muscles to reach the lower margin of the rib above. In this position they curve forward, becoming smaller and smaller by successive branching to anastomose with the superior seven or eight intercostal branches of the internal mammary, and the inferior three or four with the epigastric upon the anterior wall of the abdomen.

Just at the point where each artery reaches its intercostal space, it gives off a dorsal branch which passes immediately backward to the deep muscles of the back, and a little farther on, a long delicate branch that runs along the superior border of the rib below.

Each artery is accompanied by an *intercostal vein* which opens into the azygos vein, and by one of the intercostal nerves above mentioned.

The student may now turn his attention to the lungs and heart; and first of all to the posterior mediastinum, the lateral layers of which should be dissected back, and the contained structures freed from areolar tissue.

The POSTERIOR MEDIASTINUM is formed by the reflection of the two pleuræ from the sides of the bodies of the dorsal vertebræ to the roots of the lungs. The space included between these two layers is bounded in front by the heart covered by its pericardium, and behind by the front of the spine, and is occupied by the descending aorta, azygos vein, œsophagus, pneumogastric nerves, and thoracic duct.

The *thoracic aorta*, after forming its arch, enters the posterior mediastinum upon the left side of the body of the fourth dorsal vertebra, and descends in front of the spine a little to the left of the middle line to the aortic opening of the diaphragm, through which it enters the abdomen.

RELATIONS.—It is situated at first to the left of the œsophagus; but, in the lower part of the chest, this tube crosses it very obliquely in front to reach the œsophageal opening in the diaphragm; upon its left side, it is covered by the corresponding layer of the posterior mediastinum, and is in contact with the smaller azygos vein; internally, it is in relation above with the œsophagus; anteriorly, with the heart; and behind, with the thoracic duct and spine.

Branches.—The descending thoracic aorta gives off the intercostal, œsophageal, and bronchial arteries.

The *intercostal arteries* are given off from the posterior part of the aorta in pairs, of which there are nine or ten—the two superior intercostal spaces being supplied from the subclavian. From their origin, they wind around the bodies of the vertebræ, as previously mentioned, to reach the middle of the intercostal spaces, give off a dorsal branch to the muscles of the back, and continuing along the lower borders of the ribs between the intercostal muscles, supply the muscular walls of the thorax.

The *bronchial arteries*, the proper nutritious arteries of the lungs, are subject to great variety in size, number, and origin. As a general rule, they are not larger than a small crow-quill, and are three in number, two belonging to the left, and one to the right lung; the one for the right lung originates usually from the anterior face of the commencement of the descending aorta, and the two for the left from the first aortic intercostal artery; but not unfrequently all three arise by a common trunk from the front of the aorta immediately below the arch. They enter the lungs upon the bronchial tubes, and are distributed to the parenchymatous tissue of these organs.

The *œsophageal branches*, four or five in number, and very small, come off from the anterior part of the aorta in the course of the œsophagus, to which they are distributed.

The *azygos vein* commences in the abdomen upon the right side of the bodies of the lumbar vertebræ, communicating here by a small branch with one of the lumbar veins, or directly with the inferior cava. From the abdomen, it enters the thorax through the aortic opening in company with the thoracic duct, ascends along the dorsal vertebræ in front of the right intercostal arteries, passes behind the root of the right lung, and, curving forward, opens into the superior cava. In its course, it receives the right intercostal, right bronchial, and the œsophageal veins; and, opposite the sixth vertebra, the main trunk, called the *smaller* azygos, that collects the blood from the left intercostal veins, as represented in the accompanying plate.

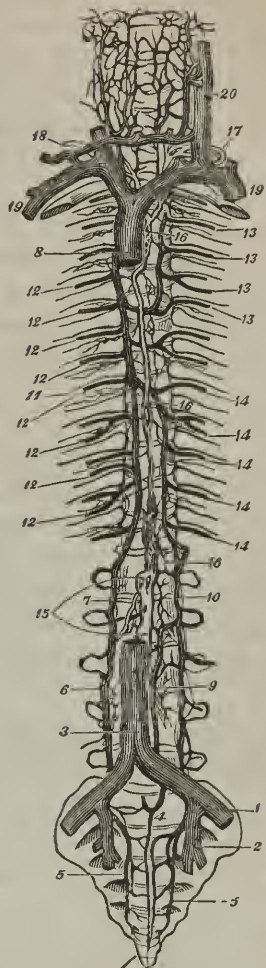
The *thoracic duct* (Fig. 226, 16, 16, 16), the main trunk of the lymphatic system, is also contained in the posterior mediastinum, but owing to its small size, and more particularly to the thinness of its coats, it cannot be easily found unless previously injected. It commences in the abdomen by an elongated dilatation, called the receptacle of the chyle (15), resting upon the front of the lumbar vertebræ beneath the right border of the aorta, where it receives the lacteals and lymphatics of the abdominal organs; it ascends through the aortic opening in the diaphragm, and maintains the same relation to the thoracic aorta as high as the fifth or sixth dorsal vertebra; here the duct passes behind the aorta, then along the left border of the œsophagus, and having reached the left side of the body

of the seventh cervical vertebra, curves forward and downward to open into the posterior part of the left jugular vein, just where it unites with the subclavian to form the left innominate vein. When injected, the thoracic duct presents a knotted, tortuous, or serpentine appearance, and gradually diminishes in size, from below upward, to within a short distance of its termination, where it again slightly dilates. The duct is sometimes double, one division taking the ordinary course, and the other (Fig. 226, 18) crossing over to open into the right jugular vein.

The *œsophagus* or *gullet*, the communicating tube between the pharynx and stomach, descends the neck between the trachea and spine, and a little to the left of the middle line. Entering the posterior mediastinum in the same relative position, it is at first upon the right side of the aorta, but as it descends, it inclines gradually across the front of this vessel to reach the œsophageal opening in the diaphragm.

The *pneumogastric nerves* reach the posterior mediastinum, and, having arrived behind the roots of the lungs, give off numerous branches, which here unite with branches from the sympathetic to form a large intimate network, denominated the *posterior* pulmonary plexus. Beyond this point the main trunk of each nerve divides into a large number of branches, which anastomose freely

Fig. 226.



Azygos veins and thoracic duct. 1. Externa iliac vein. 2. Internal iliac vein. 3. Ascending cava. 4. Middle sacral vein. 5, 5. Lateral sacral veins. 6. Origin of the greater azygos vein in the lumbar region and from the lumbar veins. 7. Its trunk. 8. Its termination in the descending cava. 9. Lnmbar veins of the left side forming at 10 the lesser azygos vein, which terminates at 11, in the greater azygos. 12, 12, 12. Eight or nine inferior intercostal veins of the right side, opening into the greater azygos vein. 13, 13, 13. Superior intercostal veins, opening by a common trunk into the greater azygos vein. 14,14,14. Five inferior intercostal veins of the left side joining the lesser azygos. 15. Receptaculum chyli. 16, 16, 16. Thoracic duct. 17. Its termination in the angle formed between the left internal jugular and left subclavian veins. 18. Right thoracic duct. 19. Subclavian vein. 20. Internal jugular.

with one another upon the exterior of the œsophagus, and are continued in this connection to the stomach.

The *lymphatic glands* of the posterior mediastinum are situated, for the most part, close to the bronchial tubes, and are hence distinguished as the *bronchial glands*. They are remarkable for their black color, firm consistence, and great liability to calcareous and other morbid deposits.

The *roots of the lungs* may now be exposed behind by dissecting off the contents of the posterior mediastinum, care being taken not to cut the lungs themselves. Each root is a broad pedicle, by which the lung is held in its position, and will be found to consist principally of a bronchial tube, a branch of the pulmonary artery, and two pulmonary veins. To these may be added the small bronchial arteries and their accompanying veins, branches of the pulmonary plexus of nerves, and lymphatics. The arrangement of the large vessels in the antero-posterior direction is the same in the two roots; thus, the bronchial tube is behind, the pulmonary artery in the middle, and the pulmonary veins in front; but from above downward the order is different; thus, in the *right* the bronchial tube is highest, the pulmonary artery next, and the veins below, and in the *left*, the pulmonary artery is above, the bronchial tube next, and the veins below.

The student should now proceed to clean the exterior of the trachea, by dissecting off the loose areolar and other tissues with which it may be surrounded.

THE TRACHEA.

The trachea or windpipe (Fig. 219) is the firm, elastic, flexible tube, extending from the larynx along the middle line of the lower third of the neck and upper part of the thorax, to the roots of the lungs, where it divides into the two bronchial tubes. It is nearly cylindrical in form, reaches from opposite the fifth cervical to the fourth dorsal vertebra, and measures, usually, in the male adult, from four to five inches in length, and about eight lines in diameter. Its size differs, however, very materially in different individuals, and is always less in the female than in the male. It is also liable to temporary variations in length, depending upon the elevation and depression of the larynx and the flexion and extension of the neck; and in diameter from its own contraction.

Relations.—The cervical portion of the trachea is covered, in front, by the isthmus of the thyroid body, the thyroid plexus of veins, and the sterno-hyoid and thyroid muscles; behind, it rests upon the front of the œsophagus which separates it from the spine, and projects a little beyond its left border; laterally, it is covered above by the lobes of the thyroid body, and is in relation below with the primitive carotid and inferior thyroid arteries and recurrent laryngeal nerves. Within the thorax it is crossed in front by the left innominate vein, the innominate artery, and the right branch of the pulmonary artery; and is in apposition, upon the left side, with the descending portion of the arch of the aorta and the left primitive carotid; on the right, with the innominate artery, and behind, with the œsophagus.

Structure.—The trachea consists of a number of different tissues: they are, 1, a fibrous coat, upon which the strength of the tube depends; 2, numerous imperfect fibro-cartilaginous rings, that give it a sufficient degree of rigidity to maintain its cylindrical form; 3, muscular fibres, to narrow its caliber; 4, yellow elastic fibres, to restore it to its natural size and position, when these have been altered by the different movements of the larynx and neck; 5, a lining mucous membrane and numerous submucous glands.

The *fibrous* constituent is a membranous cylinder consisting of two laminæ that separate at short intervals to inclose the cartilaginous rings, but unite again between them to strengthen and give continuity to the tube; it is lined internally by the mucous and muscular layers. The *rings* are imperfect, forming each only about four-fifths of a circle, and vary in number from fifteen to twenty; they are flattened from within outward, pointed at their extremities, measure from one to two lines in breadth, and are not infrequently bifid; they are situated parallel with each other between the two layers of the fibrous coat at regular intervals of about a line in width, and so arranged that their deficiencies are all upon a line posteriorly; their use, as above mentioned, is to keep the trachea always open; but, at the same time, they allow it to be narrowed to a certain extent by the approximation of their extremities. The *muscular fibres* are situated upon the inner surface of the fibrous coat behind, where they form a continuous layer, and are directed horizontally between the ends of the rings; they belong to the involuntary class, and are pale and indistinct in the human subject, but well developed in some of the inferior animals, as the ox, for example. The *yellow elastic fibres* are longitudinal in their direction, and exist in greatest

abundance along the posterior wall of the tube, between the muscular and mucous layers. The *mucous membrane* lines the interior of the tube, and is continuous above with the lining membrane of the larnyx, and below with that of the bronchial tubes; it is thin and delicate, of a pale-pink color, connected to the subjacent structures by short areolar tissue, and presents, upon its free surface, numerous minute openings leading to the ducts of the submucous glands; its epithelium is ciliated columnar. The *tracheal mucous glands* are found in greatest numbers along the posterior wall of the trachea, but exist also between the rings; in the former situation, they are placed upon the external surface of the tube, and in the latter, between the layers of the fibrous membrane; they are about the size of millet-seed, ovoidal in shape, and provided with separate ducts, which penetrate the intervening structures, and open upon the free surface of the mucous membrane.

The *arteries* of the trachea are exceedingly small, and derived principally from the inferior thyroid. Its *veins*, correspondingly diminutive, open into the thyroid plexus. Its *nerves* consist of filaments from the recurrent branch of the pneumogastric and the sympathetic.

THE BRONCHIA.—The two bronchial tubes into which the trachea divides, opposite the fourth dorsal vertebra, diverge from their origin at an obtuse angle, and enter the lungs behind the pulmonary arteries and veins. The *right* is half an inch in diameter, an inch in length, nearly horizontal, and in relation behind with the azygos vein. The *left* is a fourth smaller than the right, nearly twice as long, more oblique in its direction, and in relation behind with the aorta and œsophagus. Both have intimate relations with the pulmonary plexus of nerves, bronchial arteries and veins, and bronchial lymphatic glands. Their structure is precisely similar to that of the trachea.

Having entered the lungs, the bronchia undergo a successive branching into smaller and smaller tubes until they become almost capillary, and then terminate in the air-vesicles, of which these organs so largely consist. But, as this division and subdivision goes on, it is observed that the cartilaginous element loses its ring-like shape, and appears in the form of gradually diminishing irregular plates, which are distributed at greater and greater intervals along the tubes, and in the smaller ramifications entirely disappear. But the other constituents, namely, the fibrous, muscular, yellow elastic,

and mucous tissues are continued on even to the most minute branches. In fact, it is contended by many that the yellow elastic and muscular elements relatively increase. The mucous membrane not only lines the smallest subdivisions, but also the air-vesicles themselves.*

THE LUNGS.

The lungs occupy the lateral parts of the cavity of the thorax, to which they nearly correspond in size and form. Their *volume*, however, varies very greatly in different individuals, and in the same individual in inspiration and expiration. The two lungs are not of the same size, the right being considerably more capacious, although its vertical diameter is somewhat less than that of the left; the encroachment of the heart upon this side more than counter-balancing the difference in depth. The *weight* of the two lungs, including the trachea and bronchial tubes, when entirely freed from blood and other adventitious substances, does not often, according to the author's own observation, exceed sixteen avoirdupois ounces (one pound); but when first taken from the body, and the heart dissected off, they vary from thirty to fifty ounces. Their *specific gravity* is much less than that of water or of any organ in the body, owing to the large amount of air which they contain, and which it is impossible to separate from them without great injury to their structure. Their *color*, in infancy, is a bright light red; in the adult, a pinkish gray; and, after middle life, they present a dark mottled appearance, owing to a deposit of black pigment in the sub-serous and interlobular areolar tissue. Their *texture* is remarkably spongy and porous, and when pressed between the thumb and finger gives rise to a crackling sensation or crepitation produced by a rupture of some of the air-vesicles. Their *strength* is very considerable, as is proved by the impossibility of rupturing them by the ordinary means of inflation. They are also remarkably *elastic*, in consequence of which they rapidly collapse when the chest is opened, if they are perfectly healthy, and no obstacle exists to the escape of the air.

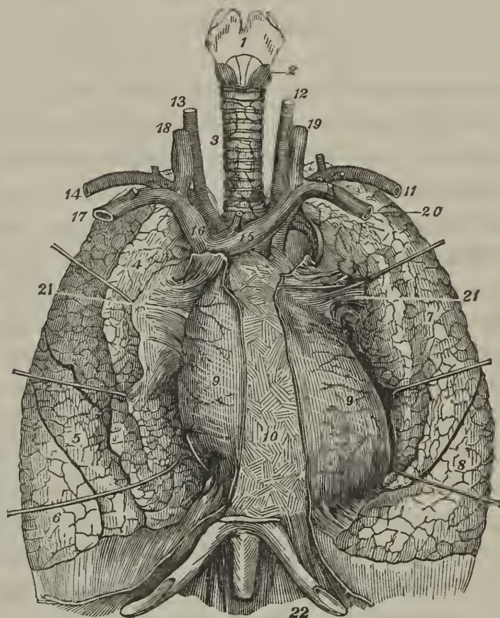
Each lung is irregularly conoidal in shape, and presents for con-

* Whether the epithelium, which is at first ciliated columnar, gradually changes to the tesselate in the smallest tubes, as stated by some recent observers, the author has not been able to determine.

sideration an external and an internal surface, a base and an apex, an anterior, a posterior, and an inferior border.

The *external surface* is smooth and convex, and corresponds precisely to the internal surface of the lateral walls of the thorax. It is

Fig. 227.



The larynx, trachea, and lungs, with the heart inclosed in the pericardium, as seen in front. 1. Thyroid cartilage. 2. Crico-thyroid muscle. 3. Trachea. 4, 5, 6, Upper, middle, and lower lobes of the right lung. 7, 8. Upper and lower lobes of the left lung. 9, 9. Pericardium investing the heart. 10. Mediastinum. 11. Left subclavian artery. 12. Left primitive carotid. 13. Right primitive carotid. 14. Left subclavian artery. 15. Left innominate vein. 16. Right innominate vein. 17. Right subclavian vein. 18. Right internal jugular vein. 19. Left internal jugular. 20. Left subclavian vein. 21, 21. Root of the lungs.

traversed from behind forward by a considerable fissure, whose sides are invested by an involution of the pleura, and are frequently found closely united by morbid adhesions. By this fissure each lung is divided into a *superior* and an *inferior lobe;* but the right has, in addition, a short fissure running from near the middle of the preceding to the anterior border of the organ, marking off a third or *middle lobe*, which is much smaller than either of the others.* The *inner surface* presents toward the median line, is concave, and corresponds in front to the heart, and behind to the bodies of the dor-

* Not very rarely the left lung has also three lobes, and the right sometimes four, or even five.

sal vertebræ. Somewhat nearer its posterior than its anterior border, and about midway between the base and apex of the organ, it gives attachment to the vascular pedicle heretofore described as the *root* of the lung. In front of the root, the surface is much more concave on the left than on the right lung, in consequence of the position of the heart, this organ being in fact almost imbedded in the left, the pericardium and an interposed reflection of the pleura intervening.

The *base* of each lung is smooth and concave, corresponding to the convexity of the upper surface of the diaphragm which forms the floor of the thoracic cavity, and being more arched upon the right than on the left side, renders the concavity of the base of the right lung greater than that of the left.

The *apex* or summit forms a blunt rounded point, somewhat flattened antero-posteriorly, and often marked in front by a superficial transverse groove corresponding to the first rib. Its highest point rises above the first rib to the distance of an inch and a half, the cavity of the thorax being prolonged for its reception behind the posterior scalene muscle, and first part of the subclavian artery.

The *posterior border* is thick and rounded, occupies the deep groove upon either side of the spine, and, owing to the obliquity of the base of the chest, is the longest part of the organ. The *anterior border* is thin and sinuous, overlaps the anterior surface of the pericardium, and is marked by two notches, of which the *superior* is quite small, and corresponds, on the left to the subclavian artery, and on the right to the superior cava vein; and the *inferior* corresponds on the left to the body and apex of the heart, and on the right to the base of this organ. The *inferior border* forms the circumference of the base of the organ, and answers to the narrow interval between the superior surface of the diaphragm and the margin of the thorax.

STRUCTURE.—The essential tissue of the lungs, the parenchyma, as it is generally called, is probably more clearly understood than that of any one of the other great organs of the body. It consists simply of the ramifications of the bronchial tubes, pulmonary artery, and pulmonary veins, held together by areolar tissue, and inclosed as a whole by the investing serous membrane.

If the surface of an inflated lung is closely examined with the naked eye, it will be found marked beneath the serous covering by numerous crooked lines crossing each other in every direction, and inclosing spaces of various shapes and sizes, which are the surfaces of as many little separate portions called *lobules*. If now the serous

membrane is dissected off (the lung of an ox is better for this purpose), these lobules may, with a little care, be entirely separated from one another except at one point where the vessels enter, for they are connected together only by areolar tissue, and have no lateral communication with each other whatever. In making this dissection, their different shapes and sizes will also be observed, each one having a number of flattened surfaces with intervening angles of different degrees for accurately filling the space which it occupies between the neighboring lobules. The vessels going to each lobule enter together at some one point, constituting a kind of root or pedicle, and consist of a branch of the bronchial tube, pulmonary artery, and pulmonary vein. The arrangement of these vessels within the lobules can be seen only by the aid of the microscope; and, as already stated, is not difficult to be understood. Thus, each branch of the bronchial tube, after entering a lobule, subdivides into a number of minute tubules, sometimes called *bronchial capillaries*, standing off from the main stem in every direction, and terminating, each one, in a bunch or cluster of minute cavities denominated *air-vesicles.* These vesicles are, therefore, the terminal expansions of the bronchial ramifications; but in all probability they consist only of the mucous lining in a state of exceeding tenuity, the fibrous, muscular, and yellow elastic constituents ceasing at the entrance of the vesicles. They are generally ovoidal and very small in the human lung, but as large as a pea or even a small hickory-nut in the alligator and some of the other lower orders of animals. They are separated from their companions in the same cluster by imperfect crests or septa; and, according to the observation of most microscopists, communicate with those of the adjacent clusters only in a retrograde way through their little bronchial stems. The branch of the pulmonary artery that enters the lobule at first follows the subdivisions of the bronchial tubes; but, having reached the air-vesicles, spreads out into a most beautiful mesh or whorl of capillary vessels situated exterior to the mucous lining; they terminate eventually in the radicles of the pulmonary veins, which abound here in equal numbers; and, having run together as it were, leave the lobule through one or more branches corresponding to that of the pulmonary artery. Each lobule, therefore, is a miniature lung, and the great function of respiration consists simply in the admission of atmospheric air into the vesicles. Here, by the diosmotic property common to nearly all animal tissues, an interchange of gaseous matters takes place through the delicate mucous

lining; the inspired air gives up its oxygen to the blood, and the blood yields its carbonic acid gas, which is obtained from the general system by a species of combustion or disintegration, to be expelled by expiration.

The interlobular areolar tissue has no adipose cells, and is therefore never subject to a deposition of fat, resembling in this respect the areolar tissue of the eyelids, penis, &c. It is not very dense, as may be proved by inflating it through a blowpipe inserted beneath the serous covering, by which means the lobules may be forced asunder, and the lung rendered artificially emphysematous. It serves not only to connect the opposed surfaces of the lobules, but, in a certain sense, isolates these organs from one another, as is beautifully exemplified in lobular pneumonia, in which the inflammation limits itself to one or more lobules, the adjacent ones remaining comparatively unaffected.

The *bronchial arteries* are the nutrient vessels of the lungs, and do not properly constitute a part of its peculiar tissue. They vary in number from one to two or three on each side, are quite small, originate from the concavity of the arch of the aorta, and follow the bronchial tubes to their remote divisions.* The *bronchial veins* correspond to the arteries, and terminate, the right in the azygos vein, and the left in the superior intercostal. The *pulmonary nerves* are branches of the pneumogastric and sympathetic nerves. Just above the root of each lung, the pneumogastric sends a small branch downward and forward to the anterior part of the root, and another to the posterior surface, which, uniting with filaments derived from the sympathetic, form the *anterior* and *posterior pulmonary plexuses*, of which the latter is much the larger. From these plexuses the pulmonary branches are derived.

The *lymphatics* of the lungs are very numerous, and consist of a superficial and a deep set; the former are situated beneath the investing pleura, and the latter ramify between and in the substance of the lobules. The two sets communicate freely, and eventually

* Notwithstanding the great bulk of the lungs is due to the large amount of air they contain, and the actual amount of solid tissue, consequently small, still, considering the active function of these organs, the bronchial arteries are relatively smaller than the nutrient arteries of any other organ in the body. Why this is so, it is difficult to say; but if calorification and actual nutrition of the tissues of the body are two separate and distinct processes, may not the temperature of the lungs be sustained by the circulation in the pulmonary artery and veins while the blood in the bronchial arteries is entirely employed for the purposes of nutrition?

terminate in the bronchial glands situated about the roots of the organs.

THE PERICARDIUM.

The pericardium (Figs. 224 and 227) is a fibro-serous sac inclosing the heart and the origins of the great vessels. It occupies the middle region of the thorax, and is inseparably connected with the upper surface of the central or cordiform tendon of the diaphragm. Laterally and anteriorly, it is covered by the pleura, beneath which on each side may be seen the diaphragmatic nerve, descending from above downward, accompanied by a small arterial twig and a corresponding vein; in front, it gives attachment to the anterior mediastinum, and is overlapped by the anterior margins of the lungs, excepting a space about an inch and a half square, which corresponds to the fifth and sixth costal cartilages on the left side; behind, it is separated from the spine by the contents of the posterior mediastinum. Its internal surface is smooth and free, kept constantly moist by serous exhalation, and always in contact with the contained organ.

Like other structures of the same class, the pericardium consists of an external fibrous and an internal serous layer. The *fibrous layer* varies in thickness and strength in different individuals, is covered externally as above mentioned, by the pleura, lined internally by the serous pericardium, continuous above with the external coats of the large vessels, and below with the tendinous portion of the diaphragm. The *serous membrane* is exceedingly thin and delicate, closely attached to the internal surface of the fibrous layer, and prolonged over upon the roots of the large vessels and the exterior of the heart, so as to constitute a simple shut sac, bearing thus the same relation to the fibrous layer and the inclosed organ that the arachnoid does to the dura mater and brain.

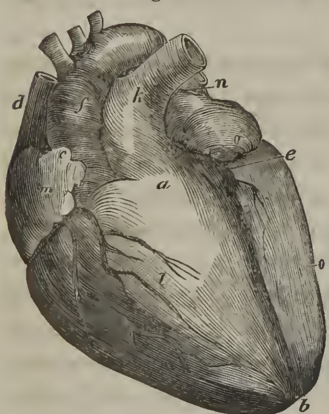
THE HEART.

DISSECTION.—Separate the heart from the lungs by dividing the pulmonary arteries and veins near where they enter these organs, and then dissect off the pericardium.

The heart is a hollow muscular organ situated in the middle of the thoracic cavity, between the two lungs and within the pericar-

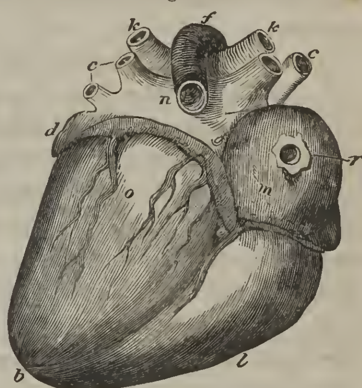
dial sac. It is retained in its position by the connections of the vessels that communicate with its cavities, by the pericardium, and by the diaphragm, upon the upper surface of which it rests. Its *size* is in a great measure proportioned to that of the development of the thorax; and this being in a great degree connected with the general development of the muscular system, it was suggested by Laennec that a man's fist is generally a tolerably good measure of the size of his heart; but its absolute volume is subject to so much variety, even within the bounds of perfect health, that it cannot be correctly compared to any familiar object. Its *weight*, liable to as

Fig. 228.



Front or upper surface of the heart and great vessels injected and placed obliquely, but its apex is not tilted forward as in the body. *a.* Infundibulum of right ventricle. *b.* Notch at apex of heart. *c.* Auricular appendage of right auricle. *d.* Cava superior. *f.* The aorta. *e, b.* Anterior longitudinal furrow, marking the division between the ventricles. *k.* Pulmonary artery. *l.* Right ventricle, of which the chief part is seen in front. *m.* Right auricle. *n.* Left auricle, seen only to a small extent, with its appendage projecting forward. There is another letter *o*, on the left ventricle.

Fig. 229.



Back or under surface of the same heart. *b.* Apex of heart, slightly notched. *c, c.* Pulmonary veins, two on each side. *d.* Appendage of left auricle *e.* Point of entrance of coronary vein into the back of right auricle, *m.* *d, e.* Indicate part of the transverse or auriculo-ventricular furrow, occupied by the large coronary vein. *f.* The aorta. *k, k.* Right and left division of the pulmonary artery. *l.* Right ventricle, only the smaller part seen. *m.* The right, and *n*, the left auricle; the division or furrow between them is distinctly seen. *o.* The left ventricle, of which the greater part is seen behind. *r.* Orifice of the cava inferior, constricted by the ligature used to keep in the injection.

great diversity as its size, is upon an average from eight to ten ounces. In *form* it resembles a flattened cone, the axis of which, when the organ is in its natural position, is directed from above downward, forward, and toward the left. Its apex corresponds to the junction of the sixth rib of the left side with its cartilage, and its base presents toward the right shoulder, and rests upon a level

with the superior margin of the fifth rib of the right side near the spine. Its general relations are those of the pericardium; and, although inclosed between the lungs, it encroaches more upon the left than the right, a deep excavation existing upon the inner surface of the former for its reception.

The Exterior of the Heart.—The external surface of the heart is closely invested by the reflected or visceral layer of the serous pericardium. It is encircled somewhat nearer the base than the apex by a deep groove, interrupted in front by the pulmonary artery, which gives lodgement to the coronary vein, and marks the internal separation of the cavities of the organ into auricles and ventricles, the base being the auricular, and the body and apex the ventricular portion.

The *auricular portion* of the heart when empty is loose and flaccid, owing to the thinness of its walls, but when distended, it projects a little beyond the circumference of the ventricular portion, and presents an irregular cuboidal form. Its *anterior* surface is marked by a deep vertical notch inclosing the pulmonary artery and aorta as these vessels leave their corresponding ventricles; the *posterior*, more irregular, is traversed by a longitudinal groove, which corresponds to the internal septum that separates the two auricular cavities; the *superior* is marked by a continuation of this same furrow; the *right* and *left lateral* are convex and bulging, and continuous, the former with the two cava, and the latter with the four pulmonary veins.

The *ventricular portion*, much more firm and resisting than the preceding in consequence of the greater thickness of its walls, is conoidal, slightly flattened obliquely from above downward and backward, and presents for examination an anterior and a posterior surface and two lateral borders. The *anterior surface* is convex, looks upward and forward toward the sternum and cartilages of the left true ribs, and is marked near its left border by a longitudinal furrow which corresponds to the septum that separates the two cavities within. The *inferior* or *posterior surface* is flattened, rests upon the central tendon of the diaphragm, and is also traversed by a longitudinal furrow situated midway between the two borders, and continuous with the one upon the anterior surface over the apex of the organ, forming here a distinct notch. Of the two *borders*, the *left* is thick and rounded, and corresponds to the deep excavation in the left lung; the *right* is comparatively thin, and rests upon the diaphragm.

The Interior of the Heart.—The interior of the heart consists of two lateral cavities separated by a common wall or septum, and lined by an exceedingly delicate membrane, called the *endocardium*, continuous with and similar in structure to the lining membrane of the veins and arteries. They are commonly designated the *right* and *left sides* of the heart, and are subdivided each into two compartments, called the auricle and ventricle, which communicate with one another through a large opening. We have therefore a right auricle and ventricle and a left auricle and ventricle.

The *right auricle* forms the right anterior part of the base of the heart, is irregularly triangular pyramidal in shape, rests upon the diaphragm, and is prolonged anteriorly in front of the root of the aorta, in the form of a flattened triangular process denominated the *auricular appendage.**

DISSECTION.—Lay the right auricle open with the scissors, making a horizontal incision through the whole breadth of the cavity, about midway between the points of entrance of the superior and inferior cava veins. If this incision is not sufficient, it may be crossed by a vertical one just in front of the entrance of the superior cava. Next, wash out the blood and fibrinous clot that nearly always occupy the cavity. These clots, called by the older anatomists *polypi of the heart*, under the supposition that they were organic growths, are sometimes quite large, and occupy not only the auricle, but extend into the ventricle, and, for a little distance, into the pulmonary artery and cava veins; they have a bright yellow color, and are firm and closely adherent to the walls of the cavity. They are the result of the coagulation of the blood just before or immediately after death, and the separation of the fibrin from the red globules is probably owing to the slowness with which the coagulation takes place, thus giving the globules time to settle toward the more dependent part of the heart, which is generally the upper and back part of the auricle. Hence, the portion of the clot drawn out of the right ventricle will generally be found nearly free from red globules, and consists of almost pure fibrin. The formation of the clot is not, according to the author's limited observation, connected with any particular form of disease, and occurs in at least three subjects out of four.

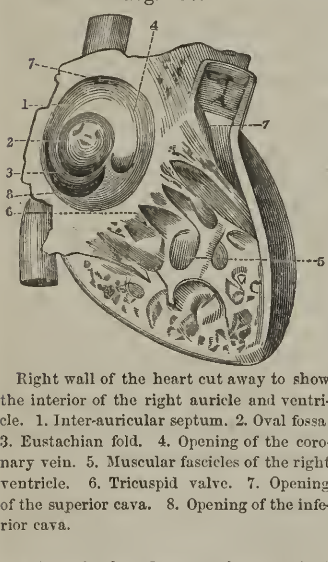
The cavity of the right auricle (Fig. 230) is separated from that of the left auricle by a common wall or partition, called the *inter-auricular septum* (1), upon the surface of which near its posterior margin is a large oval-shaped depression, called the *oval fossa* (2), corresponding to the inter-auricular opening (oval foramen) of the fœtal heart. Not unfrequently the opening is only partially closed for some time after birth, giving rise to the condition known as the cerulean or blue disease, and it often remains through life not

* From some resemblance in shape that this appendage bears to a dog's ear (*auricula*, a little ear), the name auricle was originally derived.

entirely closed, but sufficiently so to prevent any injurious admixture of blood. The inner surface of the outer wall is smooth and even, except in the vicinity of the auricular appendage, where the muscular fibres are collected into vertical bundles called, from some resemblance they have to the teeth of a comb, the *pectinate fibres* (*musculi pectinati*). In the spaces between these bundles the muscular tissue is almost entirely wanting, and the endocardium and serous pericardium being separated from one another by only a little fibrous tissue, the walls in this situation are so thin as frequently to be transparent.

The right auricle receives the venous blood from all parts of the body by three principal vessels, namely, the superior and inferior cava and coronary veins. The opening of the *superior cava* (7), situated upon the upper anterior part of the wall of the cavity, is as large as the caliber of the vessel itself, circular in shape, and looks almost directly downward. That of the *inferior cava* (8), somewhat larger than the preceding, is placed at the lower back part of the auricle, and directed obliquely upward and toward the inter-auricular septum. Between these two orifices the wall of the auricle is a little thicker than elsewhere, and in some of the inferior animals forms a prominence upon the inner surface denominated the *tubercle of Lower*. Immediately below and in front of the opening of the inferior cava is that of the *coronary vein* (4), by which the blood that circulates in the substance of the walls of the heart, is carried into the right auricle; it is about the size of a large goose-quill, and partly concealed by a delicate semicircular fold of the endocardium forming an imperfect valve (coronary or Thebesian valve), which often presents a cribriform or torn appearance. Between the mouths of the inferior cava and coronary veins, and extending from the inferior margin of the former to the inferior border of the oval fossa, is a triangular fold of the lining and muscular substance of the auricle, called the *Eustachian fold* (3), which is the remains of the fœtal continuation of the inferior

Fig. 230.



Right wall of the heart cut away to show the interior of the right auricle and ventricle. 1. Inter-auricular septum. 2. Oval fossa 3. Eustachian fold. 4. Opening of the coronary vein. 5. Muscular fascicles of the right ventricle. 6. Tricuspid valve. 7. Opening of the superior cava. 8. Opening of the inferior cava.

cava. It varies in size in different individuals, being sometimes almost wanting; and again, as in a specimen in the author's possession, it is nearly as perfect as in its original state.*

By means of the three large venous orifices all of the venous blood from all parts of the body is poured into the right auricle, whence it is transmitted, by a slight contraction of the walls, into the right ventricle through the large passage called the *right auriculo-ventricular opening.* This opening, situated at the junction between the two cavities, is oval in shape, nearly an inch and a half long, and about an inch in breadth, and provided with a set of valves, which will be seen in the examination of the right ventricle.

The *right ventricle* is situated below the right auricle and to the right and somewhat in front of the left ventricle; it is triangular pyramidal in shape, its base presenting toward the auricle; and, when distended, presents a large oblique prominence in front and above, corresponding to an internal dilatation called the infundibulum, which leads to the origin of the pulmonary artery.

Dissection.—To expose the interior of the right ventricle reflect upward a V-shaped flap from its anterior wall of the cavity; or else make a T-shaped incision, the vertical line of which shall extend the whole length of the cavity, and the horizontal one across its base, about half an inch below its junction with the auricle.

In making this dissection, it will be observed that the walls of the ventricle are much thicker than those of the auricle, the reason for which is readily understood by reference to the larger amount of labor performed by the former. The auricle has only to send the blood to the ventricle, which is situated immediately below, and communicates by a large opening; but the ventricle has to transmit it through the pulmonary artery and its subdivisions to the lungs—an act which requires considerable power, and a corresponding development of muscular tissue. This explanation applies also to the left ventricle, which, having a far more laborious function to perform than the right, has also proportionably thicker walls. It will be also noticed

* In the specimen referred to, obtained from a male adult, the inferior cava is to all intents and purposes continued through the cavity of the auricle up to the circumference of the oval fossa (which is entirely closed), presenting anteriorly an elliptical opening with well-defined margins. Its examination completely dispelled all doubts in the author's mind in regard to the transmission of the blood of the inferior cava of the fœtus through the oval opening into the left auricle.

that the walls of both ventricles are much thinner at the apex than elsewhere, and if it were not that contraction of the organ commences at this point, rupture of the heart would be a much less infrequent accident than it is.

The internal surface of the right ventricle (Fig. 230) presents a remarkable reticular appearance, due to numerous muscular fascicles, called *fleshy columns* (*columnæ carneæ*), which cross each other in every direction. Of these muscular bundles, some are large and some small, some project into the cavity of the ventricle by one side as it were, some run free from one point to another, and others again, generally the largest, have delicate tendinous extremities (*chordæ tendineæ*) by which they are attached to the free margins of the auriculo-ventricular valves.

The internal wall, or that presenting toward the opposite ventricle, is common to the two, and hence called the *inter-ventricular septum;* its surface is convex upon the right and correspondingly concave upon the left side. The two openings communicating with the cavity are the right auriculo-ventricular and the pulmonary, and are both situated at its base, the latter in front and to the left of the former.

The *right auriculo-ventricular foramen*, communicating as its name indicates between the right auricle and ventricle, is very large, oval in form, and provided with a valve denominated the tricuspid. The *tricuspid valve* consists of three divisions, one of which is larger than the others. Each is irregularly triangular in shape, thin and translucent, and attached by one border to the circumference of the opening where the three divisions are continuous; the other borders sometimes present a nodulated appearance, and give insertion to the tendinous cords of the muscular bundles. The largest of the three divisions is situated upon the left side of the opening, and partly conceals from view the orifice of the pulmonary artery. The function of the tricuspid valve is to prevent the return of the blood into the auricle during the contraction of the ventricle. Thus, while the blood is passing through the opening from the auricle the valve lies smoothly against the inner surface of the ventricle, the large division over the mouth of the pulmonary artery; but when the ventricle contracts, the valve is pressed outward by the blood as far as the tendinous cords will allow, which is just sufficient to close the opening, and to keep it closed until the ventricle relaxes and the weight of blood, which has in the mean time accumulated in the auricle, forces it back.

The tricuspid valve is formed of a doubling of the endocardium, strengthened by a little intervening fibrous tissue.

In front of the auriculo-ventricular opening, the cavity of the ventricle presents a sort of funnel-shaped prolongation obliquely upward and toward the left, at the termination of which is the *orifice of the pulmonary artery*. This opening is circular in shape, about three-fourths of an inch in diameter, and guarded by three valves called from their shape *sigmoid* or *semilunar*, or more properly the *pulmonic valves*. These, like the tricuspid, consist of a fold of the lining membrane and a small amount of inclosed fibrous tissue. They are crescentic or semilunar in shape, and placed side by side at the mouth of the artery, to which they are attached by their convex borders. Their free borders are slightly fenestrated; they contain at the centre a minute fibrous nodule, called the *Aurantian body*, and look, when the blood is passing from the ventricle, in the direction of the artery. Behind the valves the artery presents a like number of slight enlargements called the *pulmonic sinuses*. The function of the semilunar valves is to prevent regurgitation of the blood during the filling of the ventricle, which they do by being forced out against one another in the axis of the orifice by the pressure of the blood when the contraction of the ventricle ceases. From the right ventricle, the blood is sent to the lungs to be aerated, whence it is returned by the four pulmonary veins to the left auricle.

The *left auricle* is situated upon the base of the left ventricle and upon the left side of the right auricle. It is irregularly cuboidal in shape, and prolonged anteriorly in the form of a flattened constricted process called the *auricular appendage*, which when distended, overlaps the root of the pulmonary artery. Its interior (which may be exposed by incisions similar to those directed for opening the right auricle) is quite smooth, and almost destitute of that *pectinate* appearance noticed upon the inner surface of the right auricle. The oval fossa, existing upon the right surface of the inter-auricular septum, is wanting upon the left. The only points of great interest connected with the interior of this cavity are, 1, the openings of the four pulmonary veins found at its four superior corners; 2, the small constricted communication with the auricular appendage; and, 3, the large auriculo-ventricular opening below, which is better studied in connection with the ventricle.

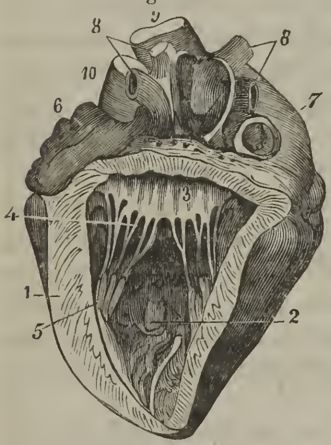
The *left ventricle* is situated to the left of and behind the right ventricle, from which it is marked off upon the exterior by the inter-

ventricular grooves. It is almost regularly conoidal in shape, and, being somewhat longer than the right, projects beyond the latter to form the greater part of the apex of the heart.

DISSECTION.—To expose the cavity of the left ventricle, remove nearly the whole of its external wall by two longitudinal incisions made within half an inch of the two inter-ventricular grooves meeting at the apex, and joined above by a transverse one near the base, including thus a large triangular piece.

In making this dissection, it will be observed that the walls of the left ventricle are three or four times as thick as those of the right, a circumstance, which, as previously mentioned, is connected with the greater labor required of this cavity in sending the blood to all parts of the system; at the apex, however, they are very thin. The size of the cavity is usually stated to be less than that of the right, but recent experiments, conducted in a manner to insure accuracy, have proved that if there is any difference at all, it is in favor of the left. It may be stated in a general way, therefore, that their capacities are about the same, although varying greatly in different individuals. The internal surface of the left ventricle presents the same reticulated appearance observed in the right, but the fleshy columns are generally smaller and more numerous, and the meshes or interspaces much closer. There are two exceptions, however, to the general smallness of the muscular bundles, for upon the anterior and posterior surfaces are two fleshy columns much larger than any in the right cavity, from the summits of which are given off the tendinous cords that control the valves of the auriculo-ventricular opening. The internal or right wall of the cavity, formed by the inter-ventricular septum, is concave. The *left auriculo-ventricular opening* is nearly similar to the right in size and shape, and like it is provided with a valve, which is divided into two parts, and hence, sometimes called the *bicuspid*, but more commonly the *mitral*

Fig. 231.



The left ventricle laid open. 1. Its parietes. 2. Its cavity. 3. Mitral valve. 4. Tendinous cords. 5. Fleshy columns. 6. Right auricle. 7. Left auricle. 8, 8. The four pulmonary veins. 9. Aorta. 10. Pulmonary artery.

valve, from the circumstance that the larger of its two divisions is shaped somewhat like a bishop's mitre. In structure, it is also similar to the tricuspid, but is much thicker and stronger, and provided with a greater number of tendinous cords. Its function is to prevent the return of the blood into the left auricle during the contraction of the ventricle. But the large division being placed just over the mouth of the aorta, it is also supposed to perform an equally important office in preventing the blood from entering this vessel until the ventricle contracts, when the valve is pressed out to close the auriculo-ventricular opening. In connection with this, it may be mentioned that it is more than probable that the contraction of the heart is in a great measure brought about by the mechanical distension of its cavities, just as the bowel, for instance, is made to contract by the pressure of its contents. Now, this distension could not occur if there were no obstacle to the free passage of the blood out of the cavity while being filled. The student will better understand this by cutting through the auriculo-ventricular opening, and spreading open the cavity, when he will observe that the mouth of the aorta is entirely covered up by the large mitral valve.* The *aortic opening*, situated in front and to the right of the auriculo-ventricular, is almost perfectly circular in shape, and provided with three valves, called the *aortic*, *sigmoid*, or *semilunar valves*, precisely like those at the mouth of the pulmonary artery, except probably that they are thicker and stronger; the little nodule called the Aurantian body, found in the middle of the free margin of each, is also somewhat larger. Behind these valves, the aorta is considerably dilated, forming as many pouches, called the *aortic sinuses*, in the upper part of two of which may be seen the mouths of the two coronary or cardiac arteries.

Structure.—The heart is composed in a great measure of muscular tissue inclosed between an investing and a lining membrane. The investing membrane is the visceral layer of the serous pericardium already described. The lining membrane, called the *endocardium*, is exceedingly thin and delicate except where it is folded upon itself to form the valves; it is continuous with and similar in structure to the internal coat of the bloodvessels; and is somewhat

* It may be objected to this theory of mechanical distension that it does not hold good in reference to the right side; but this is not the case, for the largest of the three divisions of the tricuspid valves is placed directly over the entrance of the pulmonary artery, although it does not entirely conceal it. But in neither case is an *entire* closure necessary.

thicker and more liable to disease upon the left than upon the right side. The *muscular tissue* of the heart constitutes the great bulk of the organ, and its fibres, although red and imperfectly striated, belong to the involuntary class. It is disposed in the form of bands or layers held together by an exceedingly delicate areolar tissue spreading over the auricles and ventricles, and arranged in a very intricate manner. All of the fibres, however, both of the auricles and ventricles, have their origin or fixed point of action in two fibrous rings surrounding the auriculo-ventricular openings, and connected with the valves that guard these openings; that surrounding the left being the thicker and stronger of the two. *The fibres of the auricles* consist of two sets, the one superficial, common to the two cavities; the other deep seated, and proper to each. The *common* fibres form a very thin and incomplete layer; they are for the most part directed transversely across the anterior and posterior surfaces, and are best seen near the junction of the auricles with the ventricles. The *proper* fibres are disposed separately in a looped or arched manner over the auricles, and attached by their two extremities to the corresponding fibrous rings, excepting those upon the auricular appendages, which form a series of concentric circles around these cavities, and are prolonged for a short distance upon the cava and pulmonary veins.

The *fibres of the ventricles*, like those of the auricles, belong to two general divisions, one superficial and common to the two cavities, and the other limited to each. The *common* fibres form a succession of layers, which, originating from the fibrous zones above mentioned, run in an oblique or spiral manner around the heart (those in front passing downward from right to left, and those behind from left to right), and turn inward to form the inter-ventricular septum and fleshy columns. The *proper* fibres are both spiral and circular, but their arrangement has not been accurately determined.

Besides the fibrous rings forming the circumference of the auriculo-ventricular openings, two smaller ones are found at the pulmonary and aortic orifices, which give attachment on the one side to some of the muscular fibres of the ventricles, and on the other, to the two corresponding arteries.

The *nutritious arteries* of the heart, two in number, and named the *cardiac* or *coronary* (Fig. 208), originate from the aortic sinuses.*

* The mouths of the coronary arteries being situated behind the semilunar valves, it is probable that the blood does not enter them as it passes from the

The *right*, the larger, passes forward between the origin of the pulmonary artery and base of the right auricle, and turning to the right enters the auriculo-ventricular groove, which it follows to the back of the organ to inosculate with the left coronary. It gives off posteriorly a large branch that descends along the posterior inter-ventricular groove, and is distributed to the muscular substance on each side as far as the apex. The *left* makes its appearance between the left auricle and the root of the pulmonary artery, and after descending a little way, divides into two branches, one of which turns off to the left, enters the auriculo-ventricular groove, and inosculates with the right, while the other descends along the anterior inter-ventricular groove to meet the descending branch from the right.

The *coronary vein*, the main trunk by which most of the venous blood from the walls of the heart is transmitted, commences by the confluence of numerous branches over the apex of the organ, ascends along the anterior inter-ventricular groove as far as the junction between the auricles and ventricles, then turns off to the left, running along the auriculo-ventricular groove to the back part of the organ, where, having received a large number of branches, it becomes much enlarged, and terminates by perforating the lower back part of the right auricle.

The *lymphatics* of the heart are numerous, and for the most part accompany the coronary vessels. Those on the right unite at the base of the organ in a common trunk, which passes over the arch of the aorta, then between the innominate and left common carotid arteries, and along the trachea to reach the right lymphatic trunk in the neck. Those from the left side also unite at the base of the heart to form a single vessel, which, passing along the pulmonary artery, ascends behind the arch of the aorta, and opens into the thoracic duct. The *nerves* of the heart are branches from the sympathetic and pneumogastrics. The cardiac branches of the sympathetic come from the three cervical ganglia on each side, as heretofore described; these uniting with offsets from the main trunk of the pneumogastrics and their recurrent laryngeal branches, form the *cardiac plexus* which is situated upon the concavity of the arch of the aorta in front of the trachea. From this plexus, which is very small, all parts of the organ are supplied.

ventricle, but is driven into them by the elasticity of the aorta after the closure of the valves. If this be the case, the pulse or beat of these vessels is the pulse of regurgitation, and is alternate with that of every other artery in the body.

THE BACK.

Although the back, in a surgical point of view, is one of the least important regions of the body, it possesses some points of interest which should be carefully studied. Of these, the middle line or ridge formed by the spinous processes of the vertebræ is of the most practical value. By this, the surgeon judges the existence of fracture, dislocation, or curvature. Its direction is not often perfectly straight; generally a slight lateral curvature, with its convexity presenting to the right, may be detected on a level with the shoulders, which, it is said, is caused by the bending of the body toward the left in lifting heavy weights or making other violent efforts with the right arm. In left-handed persons, Beclard found the curvature reversed. Not infrequently, a slight compensating curvature is observed in the lumbar region with its convexity presenting toward the opposite side.

Beneath the skin of the back is a very thick firm layer of areolar tissue, which, if the subject has been lying some time, will be found filled and discolored with bloody serum. Underneath the areolar tissue are the muscles, which are for the most part spread out in the form of broad layers.

The muscles of the back are very numerous, and arranged in several successive layers, of which six are generally recognized, but the number may be very conveniently reduced to four. In the first two or three layers, they are large and few in number, but next the bones they are very numerous, and many of them very small. In dissecting the latter (which is hardly advisable unless the student is ambitious of becoming a *thorough* anatomist), it will be found that the attachments of many do not precisely correspond to the description; for in this respect there is the greatest variety. If the student in a first dissection and upon an adult subject succeeds in distinguishing the small muscles of this region, he has reason to congratulate himself on his success. And it is hardly necessary to add that, to commit to memory their detailed origin and insertion is as useless as it is difficult. Let him bear in mind, however, that these remarks have reference only to the deeper layers; the more superficial deserve a careful dissection.

THE FIRST LAYER.

The superficial layer comprises but two muscles on each side, the *trapezius* and *latissimus*.

Dissection.—Place the subject in a prone position with a block under the thorax and the arms hanging over the side of the table. The parts having then been sponged clean, make an incision through the skin extending over or close by the side of the spinous processes of the vertebræ, from the occiput to the first or second lumbar vertebra, and another from the seventh cervical vertebra transversely across to the acromion. The two flaps of skin may be now turned back and afterward the areolar tissue; or both the skin and areolar tissue may be removed together, dissecting as usual in the course of the subjacent muscular fibres, whose direction is seen in Fig. 232.

Having reflected the flaps so far as to display the whole extent of the trapezius muscle, the latissimus may be brought into view by extending the median incision nearly as far as the point of the sacrum, intersecting it by another along the posterior third of the iliac crest, and dissecting back the integument and subcutaneous areolar tissue in one layer.

The trapezius muscle (Fig. 232, 1), broad, flat, and triangular, arises from the posterior third of the superior curved line of the occiput, from the fibrous intersection called the *nucha ligament*,* stretched between the external occipital protuberance and the seventh cervical vertebra, and from the spinous processes of the last two cervical and all the dorsal vertebræ. From this extensive origin the fibres converge in the direction of the shoulder, and are inserted into the posterior border of the scapular third of the clavicle, external edge of the acromion, and spine of the scapula the whole length of the upper lip of its free border. The origin consists mostly of mixed tendinous and fleshy fibres, except that portion from the two lower cervical and three or four upper dorsal vertebræ, which is entirely tendinous, and forms with its fellow of the opposite side a long, oval-shaped, glistening surface in this situation. The insertion is also tendinous and fleshy, the lowermost fibres forming a flat tri-

* The nucha ligament in some of the inferior animals, the ox and horse for example, is a thick layer of yellow elastic tissue, called whit-leather, extending between the back of the head and the spinous processes of all the cervical and some of the dorsal vertebræ, and is intended to support the weight of the head; but in the human subject, the head being erect, no such structure is needed; and, hence, there is only a median raphé or fibrous union between the muscles of the two sides in this situation. It is to this raphé that the term nucha ligament is improperly applied.

angular tendon, which glides over the root of the spine of the scapula with a synovial bursa intervening.

Use.—To elevate and carry the shoulder backward; or, if only the lowermost fibres act, to rotate the scapula, turning its inferior angle forward.

Relations.—The trapezius is covered only by the skin, subcutaneous areolar tissue, and a thin, imperfect, aponeurotic membrane. It lies upon several muscles of the second layer, and also overlaps the latissimus for a short distance where it originates from the lower dorsal vertebræ. At its anterior superior margin, the terminal branches of the spinal accessory nerve will be seen entering the muscle.

The latissimus or dorso-humeral muscle (*latissimus dorsi*, Fig. 232, 4), very broad, thin, and triangular, crosses the whole of the lower part of the back and loins. It takes its origin from the spinous processes of the lower six or seven dorsal and all the lumbar vertebræ; from the spine of the sacrum, posterior third of the iliac crest, and the three lower ribs, indigitating here with the external oblique abdominal muscle. From all these points, the fibres curve around the trunk obliquely upward and forward, converging as they ascend; and, having reached the anterior border of the scapula, form with the greater teres muscle a large, rounded, fleshy mass, which constitutes the posterior boundary of the axilla, and is inserted by a broad flat tendon into the inner or posterior edge of the bicipital groove of the humerus. Its origin from the ribs is fleshy, but that from the lumbar vertebræ, sacrum, and ilium is a very dense, strong, aponeurotic expansion, which is the posterior of the three layers of the lumbar fascia, and is the principal structure upon which the strength of this part of the body depends.

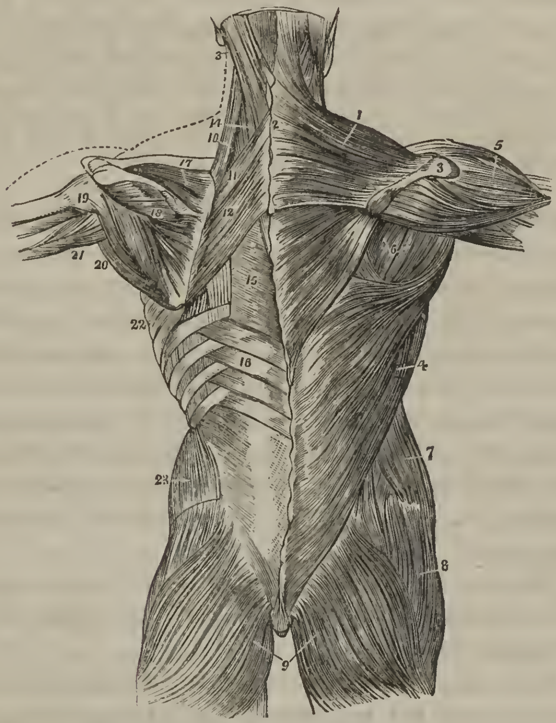
The flat tendon by which it is inserted into the humerus, although closely connected, is not blended with that of the greater teres muscle, but lies in front of it, and reaches a little higher upon the bone.

Use.—To depress the arm obliquely backward, and also to rotate it slightly inward; or, if the arm is elevated and fixed, its greatest power is displayed in elevating the body, and by its origin from the ribs it assists somewhat in dilating the thorax.

Relations.—The latissimus is crossed by the integument and subcutaneous areolar tissue, and overlapped by the lower angle of the trapezius. It covers the lower part of the spinal erector mus-

cle, the inferior posterior serrate muscle, the lower lateral part of the thorax, part of the rhomboid and great serrate muscles, and the lower angle of the scapula, over which last it glides, and from which

Fig. 232.



The first and second and part of the third layer of muscles of the back; the first layer being shown upon the right and the second on the left side. 1. Trapezius muscle. 2. Tendinous portion of the same, which, with the corresponding portion of the opposite muscle, forms a tendinous ellipse on the lower part of the back of the neck. 3. Acromion process and spine of the scapula. 4. Latissimus muscle. 5. Deltoid. 6. Infra-spinous and small teres muscles. 7. External oblique abdominal muscle. 8. Middle gluteal muscle. 9. Great gluteal. 10. Elevator of the scapula. 11, 12. Rhomboid muscle (small and large). 13, 14. Splenius muscle. 15. Aponeurosis covering the spinal erector muscles. 16. Inferior dorsal serrate muscle. 17. Supra-spinous muscle. 18. Infra-spinous muscle. 19. Smaller teres muscle. 20. Greater teres muscle. 21. Long head of the triceps muscle of the arm. 22. Part of the great serrate muscle. 23. Internal oblique abdominal muscle.

it sometimes receives an additional fleshy slip. The axillary portion of the muscle is at first external to the greater teres muscle, but soon passes in front of it, and is in relation, by its anterior surface, with the axillary vessels and nerves.

THE SECOND LAYER.

The second layer of muscles comprises the *rhomboid*, *elevator of the scapula*, *superior and inferior posterior serrate*, and *splenius*.

DISSECTION.—Remove the trapezius by cutting it from its origin and turning it outward. Divide the latissimus transversely just below the lower angle of the scapula, and dissect down the lower segment to the point where the fleshy fibres join the lumbar aponeurosis, and there cut it off. The reason for leaving the aponeurosis is that the inferior serrate muscle originates from its under surface.

The RHOMBOID MUSCLE (Fig. 232, 12), broad, thin, and quadrilateral, arises from the four or five upper dorsal and the two lower cervical spines, and from the lower extremity of the nucha, passes outward and a little downward, and is inserted into the whole length of the posterior border of the scapula. That portion of the muscle which originates from the two lower cervical vertebræ and nucha, and is inserted opposite and above the root of the spine of the scapula, is separated from the rest by a slight areolar interval, and is frequently called the *smaller rhomboid*, to distinguish it from the larger portion below, called the *greater rhomboid* (*rhomboideus major* and *minor*).

USE.—To draw the shoulder backward and a little upward; or, if only the lowermost fibres act, to rotate the scapula by drawing its point backward.

RELATIONS.—By its superficial surface, it is in relation with the trapezius above and the latissimus below, and in a triangular space between these two near the scapula, with the integument and subcutaneous areolar tissue; by its deep surface, with the superior serrate and spinal erector muscles.

The ELEVATOR MUSCLE OF THE SCAPULA (*levator anguli scapulæ*, Fig. 232, 10), long, flat, and narrow compared with the preceding, is situated upon the posterior and lateral part of the neck. It arises by tendinous slips from the posterior tubercles of the transverse processes of the four or five upper cervical vertebræ; descends a little outward and backward, and is inserted into the superior angle of the scapula.

USE.—To elevate the shoulder, at the same time assisting the rhomboid in rotating the scapula by drawing upon its superior angle.

Relations.—By its external border, with the trapezius and sterno-mastoid; behind, with the splenius; and in front, with the scalene muscles.

The two posterior serrate muscles, very thin and quadrilateral, are situated, one upon the upper, and the other upon the lower part of the back of the thorax. They are continuous with each other by an aponeurotic expansion (vertebral aponeurosis), which stretches from the spinous processes of the dorsal vertebræ beyond the angles of the ribs, and extends in a vertical direction from the lower edge of one muscle to the upper edge of the other. The *superior* (*serratus posticus superior*) arises by a delicate aponeurosis from the upper dorsal and two lower cervical spines, and passes outward and downward to form a flat fleshy belly, which is inserted by separate slips into the upper borders of the second, third, and fourth ribs, just beyond their angles. It is covered by the rhomboid, and lies upon the spinal erector muscles. The *inferior* (*serratus posticus inferior*, Fig. 232, 16), also very thin, but broader than the preceding, arises in the same manner from the under surface of the aponeurotic origin of the latissimus opposite the two lower dorsal and two upper lumbar vertebræ, passes outward and upward, and is inserted by fleshy slips into the lower borders of the four inferior ribs just beyond their angles. It is covered entirely by the latissimus, and lies upon the lumbar portion of the spinal erector muscles.

Use.—The two posterior serrate muscles are muscles of respiration, but are opposed to each other; the superior assists inspiration by elevating the ribs, and thus dilating the thorax; and the inferior aids in expiration by drawing the ribs down.

Dissection.—Detach the posterior serrate muscles and connecting aponeurosis from their attachment to the spine, turn them outward, and cut them close to the ribs.

The splenius muscle (Fig. 232, 13), is long, flat, and somewhat triangular, and situated obliquely upon the back part of the neck. It arises from the five or six upper dorsal, and two lower cervical spines, and adjacent extremity of the nucha, and ascends obliquely outward. It is inserted by tendinous slips into the transverse processes of the three or four upper cervical vertebræ behind the attachment of the elevator of the scapula, into the external portion of the rough surface between the two curved lines of the occiput, and into the back part of the mastoid process. Between that por-

tion inserted into the transverse processes and that into the head, a slight areolar interval exists, which gave rise to the old division into two muscles called respectively the *splenius colli* and *splenius capitis.*

Use.—To bend the head and neck backward and to one side, and to rotate the head in the corresponding direction; the muscles of both sides acting, the head and neck are bent directly backward.

Relations.—By its superficial surface, it is in relation with the rhomboid and superior serrate below, and elevator of the scapula and sterno-mastoid above; by its deep surface, with the numerous deep muscles of the back of the neck.

THE THIRD LAYER.

The third layer of muscles consists of the *spinal erector* and *complexus.*

The SPINAL ERECTOR MUSCLE (*erector spinæ*) is situated in the deep gutter by the side of the spinous processes of the vertebræ, and extends nearly the whole length of the trunk. It divides as it ascends into a number of parts, commonly considered as separate muscles, and named respectively the sacro-lumbal, longissimus, spinalis, ascending cervical, transverse cervical, and trachelo-mastoid. The muscle commences by a pointed origin in the deep groove found between the spine of the sacrum and posterior part of the iliac crest originating from the bony surface upon which it rests, and is closely covered in by the aponeurotic origin of the latissimus. In the lumbar region, it presents itself in the form of a thick, rounded, fleshy mass, bound down behind by the aponeurosis of the latissimus, and attached in front to the transverse and articulating processes of the lumbar vertebræ. Near the twelfth rib, this mass divides into two lateral parts, of which the external is the sacro-lumbal, and the internal, the longissimus and spinalis.

The *sacro-lumbal*, the larger division, ascends a little outward upon the back of the thorax, narrowing as it ascends, and is inserted by long tendinous slips into all the ribs near their angles. By raising its inner margin, and turning it outward, a tendinous slip will also be found to originate from the angle of each successive rib, and to pass obliquely upward to the under surface of the muscle, constituting what is called the *accessory muscle.*

The *longissimus* ascends by the side of the spinous processes of the dorsal vertebræ, but is separated from them by the spinalis. It is inserted by fleshy and tendinous slips into the transverse processes of all the dorsal vertebræ, and into all the ribs between their tubercles and angles.

The *spinalis* (*spinalis dorsi*) lies on the inner side of the preceding, and is with difficulty distinguished from it. Considered as a separate muscle, it arises from the lateral surfaces of the two upper lumbar and two or three lower dorsal spines, ascends, and is inserted into the eight or nine superior dorsal spines.

The *ascending cervical* (*cervicalis ascendens* or *descendens*) is a continuation of the sacro-lumbal. It arises from the three or four superior ribs between their tubercles and angles, ascends, and is inserted by tendinous slips into the posterior tubercles of the transverse processes of the fourth, fifth, and sixth cervical vertebræ, between the tendons of the cervical portion of the splenius and the elevator of the scapula, with both of which it is more or less blended.

The *transverse cervical* (*transversalis colli*) is small, and with difficulty separated from the preceding. It is the cervical continuation of the longissimus. It arises from the transverse processes of the three or four lower cervical vertebræ, and is inserted by tendinous slips into the transverse processes of the three or four upper cervical vertebræ.

The *trachelo-mastoid*, also a continuation of the longissimus, lies upon the inner side of the preceding, and is somewhat blended with it at its origin. It arises from the transverse processes of the two or three upper dorsal and three or four lower cervical vertebræ, ascends a little outward, and is inserted into the back of the mastoid process.

USE OF THE SPINAL ERECTOR.—To keep the trunk erect, and to bend the spine in the different directions indicated by the course of the different divisions of the muscle.

The COMPLEXUS MUSCLE, exposed by the removal of the splenius, is large, thick, and elongated. It is situated in the upper back part of the neck next to the nucha, and forms the rounded vertical ridge on each side, separated by a superficial median furrow. It arises from the transverse processes of the five or six superior dorsal and three or four lower cervical vertebræ, ascends vertically by the side of its opposite fellow, but separated from it by the fibro-areolar raphé or nucha ligament, and is inserted into the inner half of the

rough surface included between the two curved lines of the occiput. The muscle contains two or three tendinous intersections, which give it a very beautiful appearance when neatly dissected and put upon the stretch.

Use.—To throw the head backward.

THE FOURTH LAYER.

The fourth layer of muscles comprises the *transverso-spinal*, *interspinal*, *supra-spinal*, *intertransverse*, *transverso-costal*, and the *oblique* and *posterior straight muscles of the head.*

Dissection.—Remove the whole of the spinal erector and complexus of one side, and dissect off the intermuscular fascia.

The Transverso-spinal Muscle.—Under this name are included the muscles usually described as three separate classes; namely, the semi-spinalis colli, semi-spinalis dorsi, and multifidus spinæ. It consists of a series of muscular and tendinous fascicles attached by one extremity to the transverse processes of the vertebræ, and by the other, to the second or third spinous processes above. They occupy the deep part of the dorsal groove, and extend from the occiput to the sacrum, varying in shape and size in the different regions. Thus, in the loins, they arise from the back part of the transverse and articular processes by flat, tendinous slips, pass upward and inward, and are inserted fleshy into the spinous process of each vertebra above. In the thoracic region, they arise by long slender tendons from the transverse processes of the lower dorsal vertebræ, ascend obliquely, and are inserted in the same manner into the superior dorsal spines. In the neck, the muscle is very large, and fills up nearly the whole of the groove by the side of the spinous processes; the fascicles, which are very numerous, and placed one above another, arise from the transverse processes of the five or six superior dorsal and the oblique processes of the four or five lower cervical vertebræ, and are inserted into the spinous processes of all the cervical vertebræ as high as the second.

Use.—To support each vertebra in its place, to bend the spine to one side, and to rotate in an opposite direction. When the muscles of both sides act, the spine is bent directly backward.

The interspinal muscles are situated, as their name implies,

between the spinous processes, and vary in size in the different regions, according to the space between these processes. They are most distinct in the cervical region, where they may be seen to consist of two lateral bundles between each two vertebræ.

Use.—To assist in bending the spine backward.

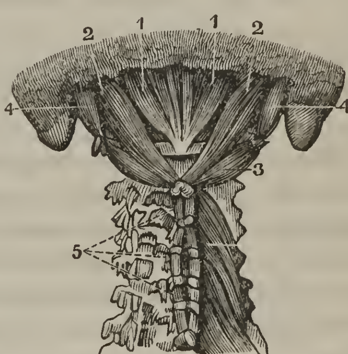
The supra-spinal muscles are small, and often with difficulty distinguished as separate muscles. They extend from the summit of each spinous process to the first, second, or third above.

The intertransverse muscles are small fleshy bundles, extending between the transverse process of the adjacent vertebræ.

Use.—To bend the spine in a lateral direction.

The transverso-costal muscles (*levatores costarum*) are a very beautiful set of little fan-shaped muscles, twelve upon each side. They originate from the summits of the transverse processes of the dorsal vertebræ, and are inserted into the rough surface of the rib below, between its tubercle and angle.

Fig. 233.



1. Small posterior straight muscle of the head. 2. Large do. 3. Inferior oblique muscle of the head. 4. Superior do. 5. Interspinal muscles.

The two posterior straight muscles of the head (*recti capitis postici major and minor*, Fig. 233), are situated beneath the complexus, and surrounded by a considerable quantity of areolar tissue. The *larger* (2, 2) one arises from the spinous process of the axis, and is inserted into the outer part of the rough surface between the curved lines of the occiput. The *smaller* (1, 1) arises from the tubercle upon the posterior arch of the atlas, and is inserted upon the inner side of the preceding. The larger muscle is not straight, but oblique.

Use.—To throw the head backward, and, when only the larger muscle of one side acts, to rotate the head in the corresponding direction.

The two oblique muscles of the head (*obliquus capitis, superior and inferior*, Fig. 233) are situated beneath and external to the

preceding. The *superior* or *atlanto-occipital* (4), the smaller of the two, arises from the transverse process of the atlas, ascends inward and backward, and is inserted into the occipital bone just behind the mastoid process. The *inferior* or *atlanto-axoid* (3) is larger than the preceding, and of a rounded form. It arises from the spinous process of the second vertebra, passes upward, outward, and forward, and is inserted into the extremity of the transverse process of the atlas.

Use.—The superior inclines the head toward the corresponding side, and throws it slightly backward. The inferior is the special muscle by which we are enabled to rotate the head to one side or the other without turning the whole trunk; it acts from the axis upon the atlas, which latter always carries the head with it in rotation.

The *vessels* and *nerves* met with in dissecting the back, are generally very small, and an account of their distribution does not, therefore, come within the scope of an elementary work.

THE SPINAL CORD.

The spinal cord is the long, narrow, cylindrical part of the cerebro-spinal axis that occupies the spinal or vertebral canal. Unlike the brain, it does not correspond in size to the cavity which contains it, but is separated from the walls of the canal by a considerable interval occupied by the membranes, spinal fluid, and a quantity of areolar and adipose tissue. The membranes will first engage attention.

Dissection.—The spinal canal may be opened either in front or behind, but the latter situation is most convenient. Dissect the muscles clean from the long gutter upon each side of the spine, and with a small saw proceed to divide the laminæ of each vertebra as near the articulating process as possible, taking care that the point of the saw does not injure the cord or its membranes. This division should be carried from the sacrum to the occiput, and the long narrow section, composed of the spinous processes and laminæ, carefully removed.

The spinal cord is covered by continuations of the membranes that surround the brain, having the same general arrangement.

The Dura Mater.—The spinal portion of the dura mater extends from the occipito-spinal foramen to the termination of the sacral

canal. It corresponds very nearly, both in shape and size, to the vertebral canal, and opposite the intervertebral foramina sends off tubular prolongations upon the nerves which leave the canal at these points. Its external surface is firmly connected to the margin of the large opening in the occipital bone, but in the rest of its extent is separated from the bony walls by a venous plexus, and a variable quantity of soft, reddish, adipose tissue. Its internal surface is smooth and glistening, being lined by the parietal portion of the arachnoid.

The Arachnoid.—The spinal, like the cranial portion of the arachnoid membrane, consists of a parietal and visceral layer, which together form but one sac.

The parietal layer lines the inner surface of the dura mater, from which it cannot ordinarily be dissected, except in small scraps. It is prolonged for a short distance into the tubular sheaths of the nerves, given off by the dura mater, and is there continuous with the visceral layer, which covers the spinal portion of these nerves.

The *visceral* layer covers the surface of the cord, but is loosely attached to it, a considerable space (*sub-arachnoid space*) occupied by loose areolar tissue and a quantity of serous fluid intervening. It also covers the roots of the nerves as far as the intervertebral foramina, where it is reflected off, to become continuous with the parietal layer lining the tubular prolongations of the dura mater.

The cavity of the arachnoid sac in the spinal canal is a continuation of the same in the cranium; its opposite walls are always in contact, and kept moist by a serous exhalation that bedews the surfaces and prevents injurious friction in the movements of the spinal column.

The sub-arachnoid space (the interval between the visceral layer of the arachnoid membrane and the cord) is continuous above with the same space upon the brain, upon whose base, it will be recollected, that this interval is of considerable size. It is occupied, as above mentioned, by loose areolar tissue, and by a certain amount of serous fluid, in which the cord may be said to be suspended. The quantity of this fluid, as ascertained by Contumnius, varies from four to five ounces, and its use seems to be to protect the cord in the different movements of the vertebral column. When suddenly drawn off from a dog, the animal is said to drop instantly upon the ground, and to remain in an apparently lifeless condition until sufficient time elapses

for its reaccumulation, when he gets up and walks off, as though nothing had happened.*

The Pia Mater.—The spinal, unlike the cranial portion of the pia mater, is a dense, strong, fibrous membrane, which surrounds the cord so closely that, when an incision is made into it, the substance of the cord protrudes beyond the cut surface. It is frequently called the *neurilemma* of the cord. Its rough filamentous exterior connects it to the visceral layer of the arachnoid by means of the sub-arachnoid areolar tissue, and gives off several thin, triangular, tooth-like processes (*dentate ligaments*), which pass transversely outward, to be attached to the dura mater in the intervals between the tubular prolongations of this membrane. The number of these processes is about twenty on each side, and their use is to fix the cord in the centre of the canal. Belonging properly to this same series of processes is the small rounded fibrous filament, that descends the canal from the extremity of the cord to be attached to the posterior surface of the coccyx.

The spinal cord is from fifteen to eighteen inches in length, and extends from the lower termination of the oblong medulla at the occipito-spinal foramen to about opposite the junction of the first and second lumbar vertebræ, where it ends in a blunt conical point. It is cylindrical in shape, and flattened in an antero-posterior direction. It is not, however, of the same size throughout, but presents two slight enlargements, one in the lower part of the cervical, and the other in the lower part of the dorsal region; below the latter, it gradually narrows to its termination. The former of these swellings corresponds to the origin of the nerves of the superior extremity, and the latter to those of the inferior. The space between the cord and the walls of the spinal canal is occupied by the structures previously mentioned, and by the origins of the nerves; the canal below the termination of the cord is filled by the large lash of nerves called the *mare's tail* (*cauda equina*), composed of the sacral and lower lumbar nerves on their way to the foramina through which they leave the canal.†

* Cruveilhier.

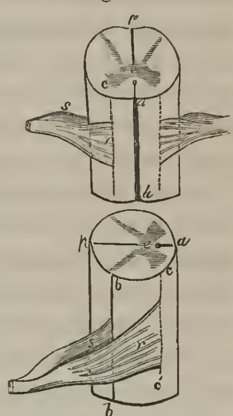
† In early fœtal life, the spinal cord occupies the whole length of the canal, but the latter becoming more rapidly developed than the former, the sacral and lower lumbar nerves become correspondingly elongated from their origin to the foramina by which they emerge from the canal.

When freed of its coverings and the numerous vessels that ramify upon its surface, the spinal cord will be seen to present two well-marked longitudinal fissures, called, from their situation, the *anterior* and *posterior median fissures.* They extend the whole length of the organ, penetrate its substance a little way, and divide it into two lateral halves or columns.

The *anterior median fissure*, more apparent than the posterior, penetrates about one-third the thickness of the cord, and is occupied by a prolongation of the pia mater; at its bottom, the two lateral halves of the cord are continuous by means of a thin layer of medullary substance called the *anterior commissure.* The *posterior median fissure*, although not so plainly seen as the anterior, is deeper; it is occupied by a prolongation of the dura mater, and its bottom is formed by the gray substance of the cord, or, according to some observers, by an exceedingly thin layer of white substance called the posterior commissure.

Besides the anterior and posterior median fissures, the spinal cord is said to present two other longitudinal fissures upon the surface of each lateral half, corresponding to the anterior and posterior origins of the spinal nerves. But of these, only the posterior is clearly demonstrable; it penetrates only to a very slight depth, and divides the lateral halves of the organ very unequally, the anterior division being much the larger. In the absence of more positive proof than at present exists, an antero-lateral fissure corresponding to the attachment of the anterior roots of the spinal nerves must be denied.

Fig. 234.



Plans in outline, showing the front and the sides of the spinal cord, with the fissures upon it; also sections of the gray and white matter, and the roots of the spinal nerves. *a, a.* Anterior. *p, p.* Posterior fissure. *b.* Posterior, and *c*, Anterior horn of gray matter. *e.* Gray commissure. *a e c.* Anterior white column. *c e b.* Lateral columns. *a e b.* Antero-lateral column. *b e p.* Posterior columns. *r.* Anterior, and *s*, Posterior roots of a spinal nerve.

Structure.—The spinal cord consists of gray and white nervous substance, the latter inclosing the former.

The *gray matter* of the cord forms a single column, occupying the centre or axis of the organ from one end to the other. Its arrangement, which is very peculiar and interesting, and its relative proportion at different points, may be ascertained by making a series of transverse sections upon a perfectly fresh specimen. The cut surfaces thus made will be found to present

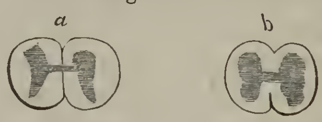
two lateral crescentic forms of gray neurine, whose convexities present toward each other, and are continuous across the middle line. The anterior extremity or horn of each of these crescents is thick and rounded, and directed toward the line formed by the origins of the anterior roots of the spinal nerves, but does not quite reach the surface of the cord. The posterior horns are long and slender, proceed backward and outward, and terminate in a slight enlargement at the bottom of the lateral fissures corresponding to the origins of the posterior roots of the nerves. The transverse mass of gray matter which connects the convexities of the crescents is called the gray commissure. It is concealed from view at the bottom of the anterior median fissure by a layer of medullary substance called the anterior commissure, and at the bottom of the posterior fissure by a still more delicate layer called the posterior commissure. The existence of the latter, however, is somewhat doubtful.

The relative proportion of the gray neurine of the cord to the white substance by which it is surrounded, is said to be as one to eight, but it varies somewhat at different points, being greatest in the lower part of the dorsal and lumbar regions, and least in the middle and upper part of the dorsal. At the extremity of the cord, this double concentric arrangement is entirely lost, and the gray matter is collected into a central mass with indented edges.

In the spinal cord of fishes, reptiles, and birds, a small central canal traverses the whole length of the organ, and communicates above with the fourth ventricle of the brain. In the human embryo, a similar canal is also said to exist, but it is obliterated shortly before or immediately after birth.

The medullary or white substance of the spinal cord is situated exterior to the gray neurine, and consists of longitudinal fibres continuous, on the one hand, with the spinal nerves, and on the other,

Fig. 235.



a. Section of the spinal cord opposite the fourth cervical vertebra. *b*. Section of the cord opposite the eleventh dorsal vertebra.

with the medullary substance of the brain. The existence and disposition of these fibres may be demonstrated by tearing a cord that

has been hardened in alcohol, or by placing a perfectly fresh specimen under a small stream of water directed upon it from a considerable height. In this manner, the bundles of fibres may be readily separated. It will then be found that the lateral columns interchange fibres only in the oblong medulla, the so-called anterior and posterior white commissures of the cord not forming true decussations, as their names would seem to indicate.

By means of the posterior horns of the gray neurine and the fissure corresponding to the attachment of the posterior roots of the spinal nerves, each lateral column of white substance is divided into two unequal parts called the antero-lateral and postero-lateral columns. The postero-lateral columns are small and wedge-shaped. They are separated from each other by the posterior median fissure, and from the anterior, by the lateral fissure and posterior horns of the gray neurine. The antero-lateral columns are much larger than the posterior, and imperfectly divided by the anterior horns of the gray neurine. The posterior division, included between the two horns, is called by some anatomists the middle column, to distinguish it from the anterior, which is situated between the anterior horn and the anterior median fissure.

The white nerve-fibres, of which the anterior, middle, and posterior columns of the spinal cord are composed, are supposed to be entirely independent of each other. Their office is to conduct impressions from the brain to the nerves, with which they are in a great measure continuous, and conversely from the nerves to the brain. Other fibres, however, than those continued from the nerves to the brain have been demonstrated as passing from one part of the cord to another, forming a connection between its different parts somewhat analogous to the antero-posterior fibres of the brain. It is now tolerably well established that some of the fibres forming the origins of the nerves do not extend to the brain, but are lost in the gray neurine of the cord. Hence it is that the cord possesses a certain power independent of the brain, as exhibited by the movements of decapitated animals upon the application of irritants to the surface.

ORIGIN OF THE SPINAL NERVES.

The spinal nerves form thirty-one separate and distinct pairs, which, with one or two exceptions, leave the canal at the interver-

tebral and sacral foramina. They are called after the divisions of the spinal column, cervical, dorsal, lumbar, &c.; the cervical group comprising eight pairs, the dorsal twelve, the lumbar five, the sacral five, and the coccygeal one. The first two cervical nerves do not pass through the intervertebral foramina, but over the laminæ of the corresponding vertebræ. The coccygeal nerve emerges at the termination of the sacral canal.

Each spinal nerve originates from the side of the cord by two distinct parts or roots, called from their relative position the anterior and posterior roots; of these, the former is entirely motor and the latter sensory in its function. The anterior or motor root is the smaller, and takes its origin opposite the anterior horn of the gray neurine, whence it passes outward to the corresponding intervertebral foramen. The posterior or sensory root originates from the sides of the lateral fissure opposite the posterior horn of the gray crescent, and passes outward in the same manner to the intervertebral foramen. The two roots, therefore, converge from their origin, perforate the dura mater together, and, having traversed the same intervertebral foramen, unite to form a single cord, which is consequently compound in its structure. Besides its greater size, the sensory root presents an oval enlargement or ganglion, which occupies the intervertebral foramen, immediately beyond which the union of the two roots occurs. The motor root, although lying in immediate contact with the anterior surface of the ganglion, has no communication with it.

The spinal cord being considerably shorter than the spinal canal, the origins of the nerves are necessarily closer than the intervertebral foramina, so that the length and obliquity of the roots gradually increase from above downward, and, in the lower dorsal and lumbar regions, become so crowded together as to entirely conceal the cord from view. The lower lumbar, sacral, and coccygeal nerves are the longest of the series. They descend almost vertically from their origin to their exit, and form the large lash called the mare's tail (*cauda equina*). Notwithstanding the great length of these nerves within the spinal canal, their anterior and posterior roots do not unite until they reach their respective foramina within which the sensory roots form their ganglia. The last or coccygeal nerve is an exception; its ganglion occurs within the sacral canal, and its two roots unite before their exit.

The compound nerves, formed by the union of the motor and sensory roots of the spinal nerves, having passed the intervertebral

foramina, divide immediately into an anterior and a posterior set of branches. The *posterior* divisions are generally very small, and are intended for the skin and muscles situated along the posterior aspect of the spinal column. The first and second cervical nerves are exceptions, their posterior branches being much the larger. The *anterior* divisions are distributed to the numerous parts situated in front of the vertebral column, including the superior and inferior extremities. They are, with the exceptions just mentioned, much larger than the posterior, and communicate at their exit with the sympathetic nerve, as represented in Fig. 26.

THE SUPERIOR EXTREMITY.

The superior extremity is connected to the trunk by the sterno-clavicular articulation and by nine separate muscles, of which two are inserted into the clavicle, namely, the sterno-cleido-mastoid and subclavian; two into the humerus, the great pectoral and latissimus; four into the scapula, the elevator of the scapula, rhomboid, omo-hyoid, and great serrate; and one into both scapula and clavicle, the trapezius. These having been already studied, the student may detach one limb at the sterno-clavicular articulation, and proceed to dissect its muscles, leaving the other connected with the trunk for the special study of the vessels and nerves.

MUSCLES OF THE SUPERIOR EXTREMITY.

The muscles of the superior extremity, excluding the nine which act upon it from the trunk, are fifty in number, and may be classified as follows:—*

I. REGION OF THE SHOULDER.

ONE CLASS—(*Movers of the Arm. Six Muscles.*)

Deltoid.
Supra-spinous.
Infra-spinous.
Small Teres.
Large Teres.
Subscapular.

The action of these muscles is so complicated as to forbid their arrangement into groups.

* After Professor Palmer, of the University of Louisville.

II. REGION OF THE ARM.

TWO CLASSES.

FIRST CLASS—(*Movers of the Arm.*) *One Muscle,* Coraco-brachial.

SECOND CLASS—(*Movers of the Forearm.*)

TWO GROUPS.

1. *Flexors* . . . .
   1. Biceps.
   2. Anterior Brachial.
2. *Extensors* . . . .
   1. Triceps.
   2. Anconeus.

III. REGION OF THE FOREARM.

THREE CLASSES.

FIRST CLASS—(*Movers of the Forearm.*)

TWO GROUPS.

1. *Pronators* . . . .
   1. Round pronator.
   2. Square pronator.
2. *Supinators* . . . .
   1. Long radial supinator.
   2. Short radial supinator.

SECOND CLASS—(*Movers of the Hand.*)

TWO GROUPS.

1. *Flexors* . .
   1. Radio-carpal flexor.
   2. Ulno-carpal flexor.
   3. Middle carpal flexor (*Palmaris longus*).
2. *Extensors* .
   1. Long radio-carpal extensor.
   2. Short radio-carpal extensor.
   3. Ulno-carpal extensor.

THIRD CLASS—(*Movers of the Fingers.*)

TWO SUBCLASSES.

FIRST SUBCLASS—(*Movers of all the Fingers.*)

TWO GROUPS.

1. *Flexors* . . . .
   1. Superficial flexor of the fingers.
   2. Deep flexor of the fingers.
2. *Extensor* . . . . . 1. Common extensor of the fingers.

SECOND SUBCLASS—(*Movers of Individual Fingers.*)

TWO GROUPS.

1. *Flexor* . . . 1. Long flexor of the thumb.
2. *Extensors* . .
   1. Extensor of the metacarpal bone of the thumb.
   2. Extensor of the first bone of the thumb.
   3. Extensor of the second bone of the thumb.
   4. Extensor of the index finger.
   5. Extensor of the little finger.

IV. REGION OF THE HAND.

First Class.

Two Groups.

First Group	1. Short Palmar.
Second Group . . .	The four Lumbricals. The seven Interosseals.

Second Class.

Three Groups.

First Group	1. Abductor of the thumb. 2. Opponens of the thumb. 3. Short flexor of the thumb. 4. Adductor of the thumb.
Second Group	1. Abductor of the index finger.
Third Group	1. Abductor of the little finger. 2. Short flexor of the little finger. 3. Adductor of the little finger.

MUSCLES OF THE SHOULDER.

Dissection.—The upper extremity having been detached from the trunk as directed, place a block beneath the arm near the axilla, so as to put the deltoid muscle on the stretch, and make an incision from the cut edge of the skin near the acromion down to the anterior aspect of the arm, as far as its middle. Next, dissect back the two flaps of skin and areolar tissue in the direction of the muscular fibres, and cut them off.

The deltoid muscle (Fig. 232, 5, and Fig. 234) is large, thick, and triangular, convex upon its cutaneous surface, and concave underneath, and situated immediately below the top of the shoulder and directly over the scapulo-humeral articulation. It arises by tendinous and fleshy fibres from the anterior border of the outer third of the clavicle, the outer border of the acromion, the lower edge of the spine of the scapula, and the aponeurosis covering the infra-spinate muscle, and is inserted by short, strong, tendinous bundles into the whole of the rough V-shaped eminence upon the outer anterior surface of the humerus just above its middle. The fibres from the acromion pass outward, and then vertically downward; those from the clavicle, downward and backward; and those from the spine of the scapula downward and forward. The muscle, from the large size of its fleshy bundles, has a remarkably coarse appearance, not unlike that of the great gluteal; and when cut into

will be found to contain numerous vertical and oblique tendinous bands, from which many accessory fleshy fibres take their origin.

Use.—The principal action of the deltoid is to elevate the arm, in which it is very slightly assisted by the supra-spinate muscle. The anterior and posterior fibres may also carry the limb alternately backward and forward. When the arm is in a vertical position, the muscle, continuing to act, presses the head of the humerus downward, and thus favors its dislocation into the axilla.

Fig. 236.

The deltoid muscle. 1. Body of the muscle. 2. Its insertion into the clavicle. 3. Its insertion into the spine of the scapula. 4. Its insertion into the humerus.

Relations.—The origin of the deltoid corresponds to, or more properly, is directly opposite the insertion of the trapezius. Its insertion occupies an angular interval in the upper extremity of the anterior brachial muscle. Its outer or convex surface is covered by the integument and a thin fascia, and overlapped above by the origin of the platysma. Its under surface is in relation with the tendon of the great pectoral muscle, the upper portion of the humerus, the capsular ligament of the shoulder-joint (a synovial bursa intervening), the acromion process, the insertion of the small pectoral, the origins of the coraco-brachial and biceps, and the insertions of the subscapular, supra-spinous, infra-spinous, and small teres muscles. Its anterior border is in contact with the biceps and the outer border of the great pectoral, but is separated from the latter near the clavicle by a small triangular interval, below which, and occupying the groove between the two muscles, the cephalic vein may be seen. Its posterior border is connected to the triceps and greater teres muscles by a strong aponeurosis.

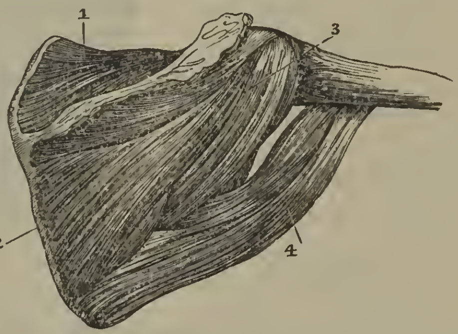
Dissection.—Cut the deltoid from its origin and turn it down, and dissect the areolar tissue and fascia from the surface of the muscles upon the back of the scapula.

The *supra-spinous fascia* is a strong fibrous membrane stretched across the fossa of the same name, and connected by its under surface to the supra-spinous muscle.

The *infra-spinous fascia* covers the muscles on the back of the scapula below the spine, and is closely connected to the posterior border of the deltoid muscle.

The SUPRA-SPINOUS MUSCLE (Fig. 237, 1) occupies the supra-spinous fossa upon the back of the scapula, to which it very nearly corresponds in shape. It arises from the bony surface upon which it rests, and, from the under surface of the supra-spinous fascia, passes outward beneath the acromion, and is inserted into the upper surface of the greater tuberosity of the humerus. It is covered above by the trapezius muscle and coraco-acromial ligament, and is in relation behind with the supra-scapular nerve and artery, and

Fig. 237.



Muscles of the dorsal surface of the scapula. 1. Supra-spinous muscle. 2. Infra-spinous. 3. Lesser teres. 4. Greater teres.

the origin of the omo-hyoid muscle. Its most important relation, however, is with the shoulder-joint, to whose capsular ligament it is so closely connected as to render their distinction almost impossible.

The INFRA-SPINOUS MUSCLE (Fig. 237, 2), flattened and triangular, arises from the under surface of the spine of the scapula and the posterior two-thirds of the dorsal surface of the bone below the spine. Its fibres pass upward and outward, and converge to a strong tendon, which glides beneath the concave border of the spine of the scapula below the acromion, becomes intimately connected with the capsular ligament of the shoulder-joint, and is inserted into the middle surface of the greater tuberosity of the humerus.

RELATIONS.—It is covered by the supra-spinous fascia, overlapped above by the deltoid muscle, below by the latissimus, and behind by the trapezius, and in the small triangular space between these three muscles, is separated from the skin only by the fascia. Its lower border is in close apposition, through its whole length, with

the small teres, but is separated from it by a thin process of the investing fascia.

The SMALL TERES MUSCLE (*teres minor*, Fig. 237, 3), small and round, as its name indicates, is situated immediately below the preceding, and is in close connection with it. It arises from the ridge and depression upon the anterior portion of the dorsal surface of the scapula, and from the aponeurotic septa separating it from the large teres and infra-spinous muscles between which it is placed; it then ascends obliquely outward along the lower border of the latter, and is inserted, by a short thick tendon, into the lower surface of the greater tuberosity of the humerus.

RELATIONS.—It is covered below by the fascia and skin, overlapped above by the posterior part of the deltoid, and inseparably connected to the lower border of the preceding muscle; its outer border is at first in apposition with the large teres, but is separated from it above by the long head of the triceps extensor of the forearm. Its tendon, like that of the preceding, is intimately connected with the capsular ligament.

The LARGE TERES MUSCLE (*teres major*, Fig. 237, 4), situated below the preceding, is much larger, and of a more flattened form. It arises from the dorsal surface of the scapula, close to the inferior angle of the bone, and, from the intermuscular aponeurotic septa, ascends outward and forward, forming part of the posterior boundary of the axilla, and is inserted by a broad, flat tendon, into the posterior border of the bicipital groove of the humerus, behind the insertion of the latissimus, and extends a little lower down upon the arm.

RELATIONS.—It is slightly overlapped at its origin by the latissimus muscle, which crosses its lower border obliquely from behind, and rises in front of it before reaching the humerus; its upper border is at first in relation with the small teres, but is afterward separated from it by the long head of the triceps, and is in contact with the lower border of the subscapular; in the interval between the biceps, latissimus, and small teres, the muscle is subcutaneous.

The SUBSCAPULAR MUSCLE is flat and triangular, and occupies the subscapular fossa, from the whole of whose surface it takes its origin. Its fibres, in passing upward, outward, and forward, converge, glide over the smooth pulley-like surface between the root of the coracoid

process and glenoid cavity, and end in a very thick short tendon, which forms a part of the capsular ligament in this situation, and is inserted into the smaller tuberosity of the humerus and adjacent surface of the bone for a short distance below.

Relations.—The posterior surface of the muscle is in contact with the surface of the bone from which it originates, and the ramifications of the subscapular artery; its deep surface lies upon the great serrate muscle, with a thin fascia intervening, and is in relation, near its insertion, with the axillary vessels and nerves; its inferior border is in contact with the great teres. The tendon of the muscle is separated from the neck of the scapula by a large bursa, and beyond this point it is continuous above and below with the capsular ligament, and lined internally with the synovial membrane, which most frequently communicates with the bursa.

Actions of the Scapular Muscles.—The supra-spinous, infra-spinous, small teres, and subscapular muscles, being inserted into the humerus very close to the shoulder-joint, which is the fulcrum of a lever of the third kind, cannot be of very great service in making those powerful and extensive movements of which the upper extremity is capable. Their function, however, is a very important one, and consists mainly in keeping the head of the humerus in place. This they do by pressing it firmly upon all sides, and presenting a strong tendinous barrier to its displacement in almost every direction. The infra-spinous and small teres also rotate the arm outward, whilst the subscapular rotates it inward.

The large teres assists the latissimus in drawing the arm downward and backward, and rotating it inward. Acting from the arm, as in climbing and crawling, it approximates the lower angle of the scapula to the humerus, and thus assists the great pectoral and latissimus in drawing the body in the direction of the fixed point.

MUSCLES OF THE ARM.

Dissection of the Anterior Brachial Region.—Extend the vertical incision made in the dissection of the shoulder, down the middle of the anterior surface of the arm, about an inch beyond the elbow-joint; and here intersect it by another made transversely across the upper part of the forearm. Next dissect back the skin and subcutaneous areolar tissue half way around the limb, so as to expose the brachial fascia or aponeurosis. When the aponeurosis has been studied, it may be removed in the same manner.

The *brachial fascia*, or *aponeurosis*, is analogous to the femoral aponeurosis; and, although very much less thick, is sufficiently strong to prevent displacement of the muscles during their contraction. It is connected above to the clavicle, acromion, infra-spinous fascia and tendons of the latissimus, great teres, and great pectoral muscles, and extends down upon the arm to the elbow, where it is connected to the internal and external condyles of the humerus, and is continuous with the fascia of the forearm. It is perforated at numerous points for the passage of bloodvessels and nerves, and is in contact by its superficial surface with the subcutaneous areolar tissue, superficial veins, and cutaneous nerves. Its deep surface is in contact with the subjacent muscles, and connected to the bone by numerous processes or septa, the two most remarkable of which are attached along the margins of the bicipital groove and the rough lines leading to the two condyles at the lower extremity of the bone; they separate the anterior from the posterior brachial region, and in the lower part of the arm serve as points of origin for muscular fibres. The space included between these two septa is occupied by the biceps and anterior brachial muscles and the brachial vessels and nerves, and communicates above with the areolar tissue of the axilla. Upon the back of the arm the fascia is very thin.

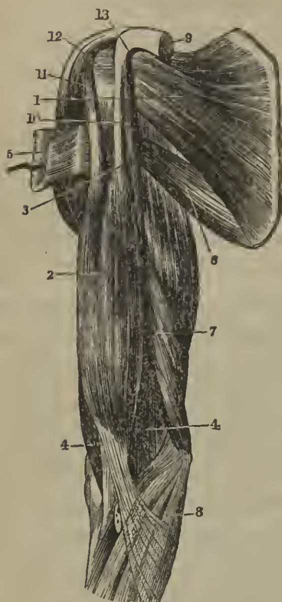
The CORACO-BRACHIAL MUSCLE (Fig. 238, 10), long and slender, arises by a pointed tendinous extremity from the summit of the coracoid process of the scapula, passes downward and a little outward, and is inserted near the inner margin of the humerus, a little below its middle.

USE.—To elevate and adduct the arm.

RELATIONS.—The origin of the muscle is between the insertion of the small pectoral and the short head of the biceps, and is intimately blended with the latter for the distance of an inch or more; in fact, the fleshy fibres originate from the inner side of the tendon of the short head of the biceps. Its insertion is blended with the process of the brachial fascia that is attached along the inner border of the humerus, and lies between the anterior brachial muscle and inner border of the triceps. The upper extremity of the muscle is covered by the deltoid, and crosses the insertion of the subscapular; its outer border is in contact at first with the short head of the biceps, and lower down with the fleshy belly of this muscle, which slightly overlaps it at its inferior extremity. Its most important relation, however, is with the brachial vessels and nerves which lie along

the whole length of its inner border. It is the satellite muscle of the brachial artery in the upper half of the arm, and the guide to the surgeon in searching for the vessel in this region for the purpose of applying a ligature. The upper part of the muscle is pierced obliquely by the external cutaneous nerve.

Fig. 238.



Muscles of the anterior brachial region; the anterior half of the deltoid cut away. 1. Subscapular muscle. 2. Biceps. 3, 6. Greater teres. 4, 4. Anterior brachial. 5. Extremity of the great pectoral. 7. Internal head of the triceps. 8. Tendinous expansion of the biceps. 9. Extremity of the small pectoral. 10. Coraco-brachial. 11. Long head of the biceps. 12. Short head of the biceps. 13. Coracoid process of the scapula.

The BICEPS FLEXOR MUSCLE OF THE FOREARM (Fig. 238, 2), is long, fusiform, and split at its upper part into two slips or heads. It is situated along the whole length of the anterior aspect of the arm, and forms in the middle and lower third of this region a large rounded fleshy mass, whose outlines are readily distinguished through the skin. The *internal*, or *short head*, arises tendinous from the coracoid process of the scapula in common with the coraco-brachial muscle, soon becomes fleshy, descends, inclining a little outward, and a little above the middle of the arm, joins the long head to form a large fleshy belly. The *external*, or *long head*, arises by a long narrow rounded tendon from the highest point of the circumference of the glenoid surface of the scapula, and is blended here with the glenoid ligament that surrounds the articular surface. It crosses outward through the upper part of the shoulder-joint, and, entering the bicipital groove upon the humerus between the smaller and larger tuberosities, it descends to join the short head. In passing through the shoulder-joint, the tendon, although within the capsular ligament, does not properly perforate the joint; the synovial membrane is reflected around it in the form of a tubular sheath, which is prolonged down the bicipital groove as far as the insertion of the tendons of the great pectoral, latissimus, and great teres muscles. In the recent state, this groove is converted into a canal by strong tendinous fibres attached along its two ridges, and continuous with the capsular ligament of the joint and the tendons

above mentioned. The large rounded fleshy belly, formed by the union of the two heads, commences about the middle of the arm, descends vertically, and, about an inch above the elbow-joint, narrows to a thick flat tendon, which passes in front of the joint. It then turns backward through the triangular space between the round pronator and long supinator muscles of the forearm, glides over the anterior part of the tubercle of the radius, a synovial bursa intervening, and is inserted into the back part of the tubercle. The inner border of this tendon gives off a broad aponeurotic expansion, which passes obliquely downward and inward in front of the elbow-joint, superficial to the brachial artery and median nerve, to become continuous with the fascia of the forearm.

Use.—To flex the elbow-joint, and also to rotate the forearm from a prone to a supine position. Having forcibly flexed the forearm, it may act in a feeble manner upon the arm, assisting in elevating and adducting it. When the forearm is fixed, as in climbing, it assists in elevating the body. The long head assists the scapular muscles in keeping the head of the humerus in place, and offers a serious obstacle to upward dislocations.

Relations.—The upper part of the muscle is covered by the deltoid and great pectoral muscles, and rests upon the humerus; but in the lower half or two-thirds of its extent, it is covered by the skin and fascia, and separated from the bone by the anterior brachial muscle. The inner border is in contact, in the upper half of the arm, with the coraco-brachial muscle; and in the lower, with the brachial artery, slightly overlapping this vessel.

Dissection.—Divide the two heads of the biceps, and turn it downward and dissect the fascia from the surface of the anterior brachial muscle.

The anterior brachial muscle, broad and tolerably thick, arises from the whole breadth of the lower half of the anterior surface of the humerus, extending upward a short distance upon each side of the insertion of the deltoid. It passes over the anterior surface of the elbow-joint, adhering closely to its thin anterior ligament, and is inserted by a short thick tendon into the coronoid process of the ulna, and into the rough surface of the bone immediately below.

Use.—To flex the forearm; it is also of great service in holding the ulna in close contact with the humerus, so as to prevent dislocation.

Relations.—Its anterior surface is in contact with the biceps

muscle, the external cutaneous nerve intervening, and with the brachial artery and median nerve, which rest upon it, near the internal border; its posterior surface is in immediate contact with the bone; its external border is closely connected to the fibrous septum, which separates it from the external head of the triceps, long supinator, and radial extensor muscles, the musculo-spiral artery and nerve intervening near the elbow-joint; its internal border is in contact above with the insertion of the coraco-brachial, and below with the origin of the round pronator muscle of the radius.

Dissection of the Posterior Brachial Region.—The posterior region of the arm contains but one muscle, the triceps, which may be exposed by dissecting off the skin and fascia. For this purpose, the muscle should be made tense by placing a block under the anterior surface of the arm, the point of the scapula being fastened back by hooks, and the forearm allowed to hang flexed over the edge of the table.

The triceps extensor muscle of the forearm occupies the whole length of the posterior surface of the humerus. It is broad and thick in the lower half of its extent, and consists superiorly of three divisions or heads, distinguished as internal, middle, and external, with reference to their position.

The *internal*, or *short head*, arises from the posterior surface of the humerus, near its inner border, by a pointed extremity, which reaches nearly as high as the insertion of the great teres, and from the intermuscular septum almost as low down as the internal condyle. The *middle*, or *long head*, arises from the superior third of the axillary border of the scapula and lower part of the circumference of the glenoid cavity, by a flattened tendon, which lies between the large and small teres muscles near their insertion. The *external head* arises from the surface of the humerus, commencing immediately below the greater tuberosity, and extending along the outer border of the bone to the external condyle, and from the intermuscular septum. From these several points, the fibres of the muscle descend; those of the middle vertically; the internal obliquely backward; and the external obliquely inward. They terminate in two large strong tendinous layers; one superficial, and the other deep seated, which unite just above the elbow-joint, and are inserted into the posterior upper part of the olecranon process of the ulna.

Use.—To extend the forearm; and, when this is accomplished, to assist slightly in carrying the arm backward, which it does through the connection of its long head with the scapula.

Relations.—The long head lies between the great and small teres muscles; is closely connected to the capsular ligament of the shoulder-joint, and is the principal obstacle to dislocation of the head of the humerus into the axilla. The deep surface of the muscle is in close contact with the whole extent of the posterior surface of the bone, except along the oblique groove, occupied by the musculo-spinal nerve and accompanying artery. The internal and external borders are closely connected to the fibrous septa that separate it from the muscles of the anterior brachial region.

The vessels and nerves met with in the dissection of the arm, are continuations of the axillary artery, vein, and plexus, and will be hereafter particularly described.

MUSCLES OF THE FOREARM AND HAND.

Dissection of the Anterior Region of the Forearm and Palm of the Hand.—Place the limb in a supine position, and fasten the thumb and fingers to the table by tacks or strong pins driven through the nails. Then divide the skin by an incision extending from midway between the condyles of the humerus to the middle of the wrist; and extend it thence along the middle of the palm of the hand and the palmar surface of the middle finger. Intersect this by two others; one across the wrist, and the other along the roots of the fingers; and turn aside the flaps on each side, leaving the fascia upon the surface of the muscles. In the hand, this dissection will be found rather difficult, owing to the close attachment of the skin to the palmar aponeurosis, but should not on this account be neglected, for it is one of no little practical importance. Lastly, dissect the skin from the palmar surface of the thumb and one or two fingers, commencing by an incision made either upon one side of each, or, more conveniently, along the middle.

When the fasciæ of the forearm and hand have been studied, they may be removed in the usual way.

The *fascia of the forearm* invests the whole of this division of the upper extremity in one common sheath, which is thicker behind than in front, and increases in thickness from the elbow to the wrist. It is attached above to the condyles of the humerus, tendons of the biceps, anterior brachial, and triceps muscles, and to the whole length of the posterior surface of the ulna; and is continuous below with the annular ligaments of the wrist and palmar aponeurosis. It is perforated at various points for the passage of bloodvessels and nerves, but is actually wanting in only one place, the bend of the elbow. Here the deficiency corresponds to the triangular space formed by the round pronator and long supinator muscles, and establishes a communication between the subcutaneous areolar tissue

and the sheaths of the muscles of the forearm. The superficial surface of the fascia is connected to the subcutaneous areolar adipose tissue, and numerous subcutaneous veins and nervous filaments hereafter to be described. Its deep surface is in close contact with the muscles, to each one of which it furnishes a separate sheath, thus rendering their dissection exceedingly tedious.

The *anterior annular ligament of the wrist* is a broad, thick, fibrous band, stretched across the deep groove upon the anterior surface of the carpus, and attached by one extremity to the pisiform and unciform bones, and by the other to the trapezium and scaphoid. Its office is to confine the flexor tendons of the fingers, of which there are nine; namely, two to each finger proper, and one to the thumb. Its superior border is continuous with the fascia of the forearm and the tendon of the middle flexor muscle of the wrist (*palmaris longus*); and its inferior, with the palmar aponeurosis. Its anterior surface is subcutaneous in the middle line of the wrist, internal to which it gives origin to the muscles of the ball of the thumb. Its deep surface is in relation with the flexor tendons and median nerve, and is lined by a reflection of the common synovial bursa that invests these tendons.

The *posterior annular ligament* is a thickened portion of the fascia of the forearm, six or eight lines in width, which passes across the back of the wrist obliquely, and is attached by its internal extremity to the pisiform bone and palmar aponeurosis, and by its external, to the lower extremity of the radius. Its office is to confine the extensor tendons of the hand, for which it forms a number of tubular sheaths by processes from its under surface. Each one of these sheaths, six in number, is lined by a separate synovial bursa, which extends some distance above the ligament, and accompanies the inclosed ligament down upon the hand sometimes as far as its insertion.*

Fig. 239.

Palmar Aponeurosis.

* Cruveilhier.

The *palmar aponeurosis* covers the deep muscles of the palm of the hand, and the flexor tendons on their way to the fingers. It consists of a middle and two lateral divisions. The middle portion is a very dense, thick, triangular and fibrous lamina, continuous above with the anterior annular ligament of the wrist and tendon of the middle carpal flexor muscle (*palmaris longus*), and inserted into the ligaments of the metacarpo-phalangeal articulations of the four fingers. Its arrangement at the roots of the fingers is worthy of careful observation. Opposite the heads of the metacarpal bones it divides into eight little slips, two for each finger, which, turning round to be inserted into the lateral ligaments of the metacarpo-phalangeal articulations, form four arched margins, beneath which the flexor tendons of the fingers pass in front of the heads of the metacarpal bones. The superficial surface of the aponeurosis is intimately united to the skin by very numerous fibrous prolongations, a variable quantity of firm areolar adipose tissue intervening; its deep surface is in relation with the palmar arterial arch, the median and ulnar nerves and flexor tendons, to which it is connected by loose areolar tissue.

The *sheaths*, or *theca of the flexor tendons of the fingers*, also seen in this dissection, consist of very thick continuous fibrous bands, which are attached along the opposite lateral margins of each phalanx, and convert the grooves upon the anterior surfaces of these bones into as many distinct canals, each one occupied by two tendons. They are lined by loose synovial bursæ, and are indispensably necessary to prevent the tendons starting from the bones during contraction.

The muscles situated upon the anterior region of the forearm are eight in number, and belong respectively to the first group of the first, second, and third class; that is, they are pronators of the forearm, flexors of the wrist, and flexors of the fingers. They nearly all originate by a common muscular and tendinous mass from the inner condyle of the humerus and inner side of the forearm, and are arranged into a superficial and a deep layer. The superficial layer comprises the *round pronator*, *radio-carpal flexor*, *middle carpal flexor*, or *palmaris longus*, *ulno-carpal flexor*, and *superficial flexor of the fingers*. The remaining three, forming the deep layer, are the *deep flexor of the fingers*, *long flexor of the thumb*, and *square pronator*. They should be examined in the order in which they are here mentioned, and, in separating them, the student should commence about the upper third of the forearm, for they are so

intimately blended at their origin as not to be readily distinguished from one another.

Fig. 240.

Muscles of the anterior region of the forearm. 1. Lower part of the biceps. 2. Part of the anterior brachial. 3. Edge of the triceps. 4. Round pronator of the radius. 5. Radio-carpal flexor. 6. Middle carpal flexor (palmaris longus). 7. One of the divisions of the superficial flexor of the fingers. 8. Ulno-carpal flexor. 9. Palmar aponeurosis. 10. Small palmar muscle. 11. Abductor of the thumb. 12. Portion of the short flexor of the thumb. 13. Long supinator. 14. Metacarpal and first phalangeal extensors of the thumb curving around the lower border of the forearm.

The ROUND PRONATOR MUSCLE (*pronator radii teres*, Fig. 240, 4), the most internal* of the superficial layer, is situated obliquely across the front of the upper third of the forearm. It arises, tendinous and fleshy, from the inner condyle of the humerus and intermuscular septa, and, by a thin tendinous expansion, from the coronoid process of the ulna, allowing the median nerve to pass between its two heads. It descends outward in the form of a round fleshy belly, and terminates in a flat tendon, which wraps around the anterior surface of the radius about its middle third, and is inserted into a rough surface on the outer side of that bone.

USE.—To rotate the radius, and, at the same time, to carry its lower extremity to the inner side of the ulna; thus turning the hand from a supine to a prone position; it is, besides, a flexor of the elbow-joint.

RELATIONS.—The origin and anterior surface of the muscle is superficial; the internal border passes obliquely across the radio-carpal flexor; the external border forms the inner boundary of the triangular space at the bend of the elbow, in which is contained the tendons of the biceps and anterior brachial muscles, the brachial artery and median nerve; the insertion is covered by the long supinator muscle, and crossed by the radial artery, veins, and nerve.

The RADIO-CARPAL FLEXOR MUSCLE (*flexor carpi radialis*, Fig. 240, 5), long and tapering, arises from the inner condyle of the humerus, and from the fibrous septa that separate it from

* The forearm is considered as placed in a supine position; and the terms internal and external, have reference to its two borders; the former corresponding to the ulna, and the latter to the radius.

the preceding muscle and the middle carpal flexor, between which it is placed. It descends outward in the form of a thick fleshy belly, and terminates a little below the middle of the forearm in a flat tendon, which passes beneath the outer extremity of the anterior annular ligament, and through a groove in the trapezium, to be inserted into the upper extremity of the second metacarpal bone.

USE.—To flex the hand at the wrist; and, secondarily, the forearm at the elbow; it also assists in pronation, and abducts the hand.

RELATIONS.—It is crossed obliquely above by the round pronator, below which, as far as the annular ligament, it is subcutaneous; it is situated at first between the pronator and middle carpal flexor, and then between this latter and the long supinator; on the wrist and hand, it is covered by the anterior annular ligament and the muscles of the ball of the thumb. Its most important relation, however, is that with the radial artery, veins, and nerves, which join the outer side of the muscle about the middle of the forearm, and continue along the corresponding side of its tendon as far as the wrist. The tendon, therefore, forms the guide to the surgeon in searching for the artery.

The MIDDLE CARPAL FLEXOR, or LONG PALMAR MUSCLE (*palmaris longus*, Fig. 240, 6), long and slender, arises from the inner condyle of the humerus and fascia of the forearm by a delicate tendon, but soon forms a small fleshy belly, from which a long slender tendon proceeds, to be inserted into the anterior annular ligament and palmar aponeurosis.

USE.—To flex the wrist, and make the palmar aponeurosis tense.

RELATIONS.—By its deep surface, with the superficial flexor of the fingers, internally with the ulno-carpal flexor, and externally with the radio-carpal flexor.

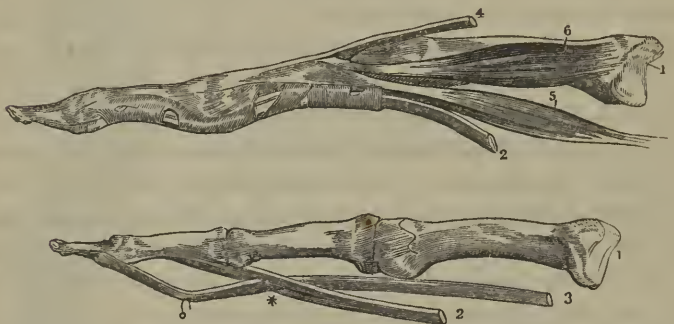
The ULNO-CARPAL FLEXOR MUSCLE (*flexor carpi ulnaris*, Fig. 240, 8) is situated more nearly on the inner border of the forearm than upon its anterior surface. It arises from the back part of the inner condyle of the humerus, and from the inner side of the olecranon process, the ulnar nerve separating its two heads. It is also connected, by means of the intermuscular fascia, to the inner edge of the upper two-thirds of the ulna. From these points, the fleshy fibres converge very gradually to a tendon, which is inserted into the pisiform bone and base of the fifth metacarpal bone.

Use.—To flex and adduct the hand.

Relations.—It is covered by the fascia and skin, lies upon the deep flexor of the fingers, and is in contact, by its radial border, in the lower two-thirds of the forearm with the ulnar artery and nerve.

Dissection.—Divide the three flexors of the wrist, and reflect their cut extremities, and the superficial flexor of the fingers will be brought into view.

Fig. 241.



The metacarpal and phalangeal bones of the fingers with the tendons. In the first figure, the tendons of the flexor muscles are bound to the finger by the fibrous sheath; in the second, they are freed from that structure, as well as from the synovial membrane by which it is lined. 1. Metacarpal bone. 2. Tendon of the superficial flexor muscle. 3. Tendon of the deep flexor; * the perforation of the former by the latter. 4. Tendon of the common extensor muscle. 5. A lumbrical muscle. 6. An interosseous muscle.

The superficial flexor muscle of the fingers (*flexor digitorum sublimis perforatus*), broad in the middle, pointed above, and divided below into four long tendons, arises from the inner condyle of the humerus, internal lateral ligament, coronoid process of the ulna, and oblique line of the radius. The four tendons commence in the lower third of the forearm, pass beneath the annular ligament, and, having reached the palm of the hand, diverge toward the fingers. At the roots of the fingers, each tendon enters its corresponding sheath (*theca*), in company with and upon the surface of the tendon of the deep flexor, and opposite the first phalanx splits into two lateral slips, which proceed forward upon each side of the tendon of the deep flexor, and, converging upon the under surface of the latter, are inserted into the forepart of the second phalanx (Fig. 241).

Use.—To flex the second joints of the fingers; then the wrist; and possibly, also, the forearm upon the humerus.

Relations.—It is covered at its origin by the round supinator, radio-carpal flexor, and middle carpal flexor muscles; the two last,

mentioned of which descend upon its anterior surface. That portion of the muscle between the middle and ulno-carpal flexor muscles is subcutaneous. It covers the deep flexor muscles, ulnar artery, veins, and nerve, and median nerve. In the hand, its tendons are situated beneath the palmar aponeurosis and palmar arterial arch, and covers the deep flexor tendons and lumbrical muscles.

DISSECTION.—Divide the superficial flexor about the middle of the forearm, and reflect back its cut extremities.

The DEEP FLEXOR MUSCLE OF THE FINGERS (*flexor profundus digitorum perforans*), shorter and smaller than the preceding, arises from the superior three-fourths of the anterior surface of the ulna and the contiguous portion of the interosseous membrane, descends along the inner side of the forearm in the form of a thick fleshy bundle, and terminates in four tendons; these pass beneath the anterior annular ligament, diverge upon the palmar surface of the metacarpus, enter the sheaths upon the fingers, pass between the slips of the superficial flexor tendons, and are inserted into the bases of the last phalanges. The tendon intended for the index finger separates higher up than the others, and often appears to belong to a distinct muscle.

USE.—To flex the last joints of the fingers; and, secondarily, the hand upon the forearm.

RELATIONS.—It is covered in the forearm by all the preceding muscles, and by the ulnar and radial vessels and nerves, which descend upon its surface; the one set along the radial, and the other along the ulnar border. Its deep surface rests upon the ulna and interosseous membrane in the upper three-fourths of the forearm, and below upon the anterior surface of the square pronator. Its tendons lie on the inner side of those of the superficial flexor while beneath the annular ligament; but in the hand and upon the fingers are placed directly beneath them. Connected to these tendons is a set of little fleshy slips, called the lumbrical muscles, which will be described in connection with the muscles of the hand.

The LONG FLEXOR MUSCLE OF THE THUMB (*flexor longus pollicis*), situated along the outer side of the preceding, arises from the upper two-thirds of the anterior surface of the radius, commencing just below the tubercle, and from the adjacent part of the interosseous membrane. The fibres descend obliquely forward to a tendon, which passes beneath the outer extremity of the anterior annular ligament

and the muscles of the thenar eminence,* and between the short flexor muscles and sesamoid bones of the thumb, and is inserted into the base of the last phalanx.

USE.—To flex the thumb upon the hand, and the hand upon the forearm.

RELATIONS.—In the forearm, it is covered by the superficial flexor of the fingers, radio-carpal flexor, long supinator muscles, and radial vessels, and rests upon the radius, interosseous membrane, and square pronator muscle. Its inner border is separated from the deep flexor of the fingers by the anterior interosseous artery and nerve.

DISSECTION.—Divide the two preceding muscles, and reflect back their cut extremities, and the square pronator muscle, covered by a thin prolongation of the brachial fascia, will be brought into view.

The SQUARE PRONATOR MUSCLE (*pronator quadratus*), flat and quadrangular, occupies the whole breadth of the anterior surface of the forearm just above the wrist. It arises by tendinous and fleshy fibres from the lower fifth of the internal and anterior surface of the ulna, passes transversely outward, and is inserted into the lower fourth of the anterior surface and outer border of the radius.

USE.—To turn the lower end of the radius over the ulna, and thus pronate the hand.

RELATIONS.—It is crossed by the tendons of the preceding muscles, and by the ulnar and radial vessels, and lies upon the ulna, radius, and interosseous membrane.

DISSECTION OF THE POSTERIOR MUSCLES OF THE FOREARM.—Having completed the dissection of the anterior region of the forearm, the student should turn the limb over, having previously placed a wet cloth upon the palmar surface of the hand to prevent the muscles of this region from becoming dry. To expose the muscles upon the back of the forearm, the skin should be dissected off, and then the fascia, commencing along either the ulnar or radial border. The skin upon the back of the hand and fingers should also be dissected off, to see the insertions of the extensor tendons.

The muscles situated upon the outer and back part of the forearm, twelve in number, are supinators and extensors of the hand and extensors of the fingers. They are arranged into a superficial and a deep layer, of which the former comprises the seven succeeding muscles.

* The ball of the thumb is called the thenar, and that of the little finger the hypo-thenar eminence.

The LONG SUPINATOR MUSCLE (*supinator longus*, Fig. 242, 4), the most superficial of the muscles situated along the radial border of the forearm, has a narrow, fleshy origin of about an inch in extent, from the external condyloid ridge of the humerus, nearly as high as the insertion of the deltoid, and from the intermuscular septa that divide it from the triceps behind and the anterior brachial muscle in front. It descends along the outer anterior part of the elbow and radius, and at about the middle of the forearm, ends in a flattened tendon which continues in the same direction, to be inserted into the outer surface of the lower extremity of the radius.

USE.—To turn the forearm and hand from a prone to a supine position, and also to assist in flexing the forearm upon the arm.

RELATIONS.—It is placed at its origin between the triceps and anterior brachial muscles, and is superficial throughout its whole course, except just above its insertion, where its tendon is crossed obliquely by the extensor tendons of the thumb, and covered by the posterior annular ligament. It rests upon the long carpal extensor above, and upon the forearm is placed at first between this muscle and the round pronator, the insertion of which it crosses, and is then external to the tendon of the radio-carpal flexor. Its inner border overlaps the radial vessels and nerve, and in the lower part of the forearm, forms the guide to the radial artery in operations upon this vessel.

The LONG RADIO-CARPAL EXTENSOR MUSCLE (*extensor carpi radialis longior*), situated behind and beneath the preceding, arises by tendinous and fleshy fibres from the lower part of the external condyloid ridge of the humerus, descends along the outer border of the elbow and the corresponding border of the radius, and terminates in the upper third of the forearm in a long flat tendon, which continues along the outer and back part of the radius, traverses a groove on the lower extremity of this bone in company with the tendon of the next muscle, and is inserted into the base of the metacarpal bone of the index finger.

USE.—To extend and abduct the hand, and when the limb is supine, also to assist in flexing the forearm upon the arm.

RELATIONS.—The fleshy belly of the muscle is covered by that of the preceding muscle, but projects beyond it behind. Its tendon lies upon the surface of the tendon of the following muscle, and is crossed by the extensor tendons of the thumb.

Fig. 242.

The superficial layer of muscles of the posterior region of the forearm. 1. The lower part of the biceps. 2. Part of the anterior brachial. 3. The insertion of the triceps into the olecranon. 4. The long supinator. 5. The long radio-carpal extensor. 6. The short radio-carpal extensor. 7. The tendons of insertion of these two muscles. 8. The common extensor of the fingers. 9. The extensor of the little finger. 10. The ulno-carpal extensor. 11. The anconeus. 12. Part of the ulno-carpal flexor. 13. The extensors of the metacarpal and first phalangeal bones of the thumb lying together. 14. The extensor of the second phalanx of the thumb—its tendon is seen crossing the tendons of the two radio-carpal extensors. 15. The posterior annular ligament. The tendons of the common extensor are seen upon the back of the hand and their mode of distribution on the backs of the fingers.

The SHORT RADIO-CARPAL EXTENSOR (*extensor carpi radialis brevior*) is exposed by the removal of the preceding. It arises from the lower back part of the external condyle of the humerus in common with the other extensor muscles, and, from the external lateral ligament of the elbow, descends upon the posterior surface of the radius in the form of a short and tolerably thick belly, and terminates about the middle of the forearm in a flat tendon. This continues in the same course, traverses the groove upon the lower extremity of the radius conjointly with the preceding, beneath which it is placed, and is inserted into the base of the metacarpal bone of the middle finger. Its action is similar to that of the last.

The ANCONEUS MUSCLE (classed with the triceps extensor, but situated upon the upper back part of the forearm) is small and triangular. It arises by a pointed tendinous extremity from the outer back part of the external condyle of the humerus, passes downward and inward, spreading out as it descends, and is inserted in the outer border of the olecranon process of the ulna.

USE.—To extend the forearm.

RELATIONS.—It is covered above by an expansion from the tendon of the triceps, but is mostly superficial; it is closely applied to the back part of the elbow-joint, and covers part of the short superior muscle.

The ULNO-CARPAL EXTENSOR MUSCLE (*extensor carpi ulnaris*), situated along the inner and back part of the forearm, arises from the back part of the external condyle of the humerus, in common

with the other extensor muscles, and for a short distance from the surface of the ulna below the anconeus, descends obliquely inward in the form of a small fleshy belly, and terminates below in a narrow tendon, which proceeds along the back part of the ulna, passes beneath the posterior annular ligament through a groove on the lower extremity of the bone, and is inserted into the base of the metacarpal bone of the little finger.

Use.—To extend and adduct the hand.

Relatons.—This muscle is superficial, except where it passes beneath the anterior annular ligament, and covers the short supinator and part of the extensor of the index finger.

The extensor muscle of the fingers (*extensor communis digitorum*), has a fleshy origin from the external condyle and intermuscular septa, and about the middle of the forearm divides into four fleshy slips, which soon end in as many long slender tendons; these pass beneath the posterior annular ligament, diverge upon the back of the hand, and are connected to each other by tendinous slips. Having reached the roots of the fingers, each tendon spreads out into a strong aponeurosis, which covers the backs of the first two phalanges and their respective joints, and, upon a close examination, will be found divided into a middle and two lateral portions, the former inserted into the second phalanx and the latter into the base of the third.

Use.—To extend the fingers and hand.

Relations.—This muscle is covered only by the skin and fascia, and lies upon the short supinator, three extensors of the thumb, extensor of the index finger, posterior interosseous artery and nerve, wrist-joint, metacarpal and phalangeal bones and articulations, and dorsal and interosseal muscles. It is situated upon the forearm, between the radio-carpal extensors and the extensor of the little finger.

Dissection.—Divide the common extensor about its middle, and reflect back its cut extremities.

The short supinator muscle (*supinator brevis*), short, flat, and triangular, is situated in close contact with the radius in the upper back part of the forearm. It arises from the back part of the external condyle of the humerus, external ligament of the elbow-joint, and adjacent part of the outer border of the ulna, curves outward and forward in an expanded form around the upper part of the radius, and is inserted into the outer and anterior surface of this

bone, between its tubercle and the insertion of the round pronator muscle.

Use.—To turn the radius upon its axis so as to supinate the hand and lower extremity of the forearm.

Relations.—It is covered by the preceding muscles that originate from the external condyle, and is in close contact with the outer side of the elbow-joint and upper third of the radius. The posterior branch of the musculo-spiral or radial nerve passes through its fibres.

The extensor muscle of the little finger (*extensor minimi digiti vel auricularis*), long and slender, arises in common with the common extensor of the fingers, behind which and the ulno-carpal extensor it descends obliquely inward in the form of a small fleshy belly; it terminates in a long, delicate tendon, which traverses a groove on the lower extremity of the radius beneath the posterior annular ligament, and unites with the fourth tendon of the common extensor to be inserted into the phalanges of the little finger.

Use.—To extend the little finger, acting either with the common extensor, or independently of it.

The extensor muscle of the index finger (*extensor indicis*) arises fleshy from the middle of the posterior surface of the ulna and interosseous membrane, descends outward, and terminates just above the carpus in a slender tendon, which passes beneath the posterior annular ligament in company with the first tendon of the common extensor, with which it unites to be inserted into the back of the second and third phalanges of the index finger.

Use.—To extend the index finger, acting either conjointly with the common extensor or independently of it, as in pointing.

The Extensor Muscles of the Thumb.—The thumb is provided with three small but distinct extensor muscles, which are inserted respectively into the metacarpal bone and first and second phalanges.

The extensor of the metacarpal bone of the thumb (*extensor ossis metacarpi pollicis*) arises from the middle back part of the ulna, interosseous membrane, and middle posterior part of the radius, and descends outward and forward in the form of a small rounded fleshy belly. It terminates in a delicate tendon, which passes beneath the posterior annular ligament, traverses a groove on the lower extremity of the radius, continues along the outer border of the wrist,

where it also occupies a groove in the trapezium, and is inserted into the base of the metacarpal bone of the thumb.

Use.—To extend the metacarpal bone of the thumb, and also to abduct it; secondarily, it extends and abducts the hand.

Relations.—Its fleshy belly is covered by the common extensor of the fingers and ulnar extensor of the wrist, and lies upon the bones and interosseous membrane; its tendon is mostly subcutaneous, and crosses the two radial extensors of the wrist.

The extensor of the first phalanx of the thumb (*extensor primi internodii pollicis*) lies along the ulnar side of the preceding, and like it arises from the ulna, interosseous membrane, and radius. Its long narrow tendon occupies the same groove in the radius, and is inserted into the base of the first phalanx of the thumb.

Use.—To extend the thumb at the metacarpo-phalangeal articulation.

The extensor of the second phalanx of the thumb (*extensor secundi internodii pollicis*) is larger than the preceding, and slightly overlaps it. It arises fleshy from the posterior surface of the ulna above the origin of the extensor of the index finger, and ends in a delicate tendon, which crosses the lower extremity of the radius in a distinct groove, and passes along the outer side of the wrist and along the ulnar side of the metacarpal bone and first phalanx of the thumb, to be inserted into the base of the second phalanx.

Use.—To extend the thumb at its phalangeal articulation. Upon the outer border of the wrist, the tendon of this muscle is separated from those of the preceding two by a triangular interval corresponding to a depression in the skin when the thumb is extended, in which the continuation of the radial artery may be felt pulsating.

MUSCLES OF THE HAND.

The muscles of the hand are all situated upon its palmar surface and between the metacarpal bones. Considered with reference to their relative position, they form three groups, namely, those of the thumb constituting the thenar eminence or ball of the thumb, those of the little finger forming the hypothenar eminence, and those occupying the middle of the palm.

The skin and palmar aponeurosis having been removed in the

dissection of the forearm, the muscles of the thenar and hypothenar eminences will first claim attention.

The *Muscles of the Ball of the Thumb* are four in number, namely, an abductor, short flexor, adductor, and the opponens.

The ABDUCTOR OF THE THUMB (*abductor pollicis*), the most superficial muscle of the thenar eminence, is flat and narrow; it arises fleshy and tendinous from the superficial surface of the anterior annular ligament and from the trapezium, passes outward and forward, and is inserted by a narrow tendinous extremity into the outside of the base of the first phalanx.

USE.—To separate the thumb from the fingers.

DISSECTION.—Detach the abductor from its origin, and turn it outward.

The OPPONENS, flat and triangular, arises from the anterior annular ligament and trapezium, and is inserted into the whole length of the radial border of the metacarpal bone of the thumb.

USE.—To approximate the metacarpal bone of the thumb to the palm of the hand.

DISSECTION.—Detach the opponens from its origin, and turn it outward; in doing this, it will be found to be very intimately connected by its under surface to the following muscle.

The SHORT FLEXOR OF THE THUMB (*flexor brevis pollicis*) is larger than the preceding, and placed beneath it. It consists of two parts, which contain between them the tendon of the long flexor. The *anterior* division arises from the annular ligament and from the trapezium and scaphoid bones, and is inserted tendinous into the base of the first phalanx on its radial side. The *posterior* arises from the magnum, trapezoid, and base of the middle metacarpal bone, and is inserted by a short tendon into the base of the first phalanx. The two divisions are at first entirely separate, but unite to form a single fleshy mass, but again divide at their insertion. Two sesamoid bones are found in the tendons, where they pass over the metacarpo-phalangeal articulation.

USE.—To flex the first phalanx upon the metacarpal bone, and the latter upon the wrist.

The ADDUCTOR OF THE THUMB (*adductor pollicis*), broad, flat, and triangular, arises from about two-thirds of the palmar surface of the

middle metacarpal bone, passes outward, its fibres converging, and is inserted by a pointed extremity into the base of the first phalanx of the thumb in connection with the preceding.

USE.—To approximate the thumb to the fingers.

The *Muscles of the Little Finger* are three in number, namely, an abductor, a short flexor, and an adductor. Lying upon the surface of these is a cutaneous muscle called the small palmar, which, however, is often so poorly developed as to escape notice.

The SMALL PALMAR MUSCLE (*palmaris brevis*) is a thin quadrangular plane of pale muscular fibres situated immediately beneath the skin of the hypothenar eminence. It arises from the annular ligament and palmar aponeurosis, passes transversely outward, and is inserted into the skin upon the inner border of the hand.

USE.—To draw the skin of the hypothenar eminence toward the middle line of the palm, as in forming the hand into a cup.

The ABDUCTOR OF THE LITTLE FINGER (*abductor minimi digiti*), flat and narrow, arises fleshy from the internal extremity of the anterior annular ligament and from the pisiform bone, passes downward along the inner border of the hand, and is inserted by a short tendon into the base of the first phalanx of the little finger upon its ulnar side.

USE.—To separate the little finger from the others.

The SHORT FLEXOR OF THE LITTLE FINGER (*flexor brevis minimi digiti*) is situated along the radial side of the preceding, and separated from it by the deep palmar branch of the ulnar nerve. It arises from the annular ligament and unciform bone, and is inserted into the base of the first phalanx.

The ADDUCTOR OF THE LITTLE FINGER, more deeply seated than the preceding, and slightly overlapped by it, arises from the annular ligament and unciform bone, and is inserted into nearly the whole length of the metacarpal bone.

USE.—To approximate the little finger to the others.

The *Muscles of the Middle Region of the Hand* are the lumbrical and interosseal.

The LUMBRICAL MUSCLES, four in number, are small, round, fleshy fascicles, which arise near the wrist from the four tendons of the deep flexor muscle of the fingers, proceed downward along with these tendons, and end in as many delicate tendons, which pass to the radial sides of the respective fingers, and, uniting with the tendons of the interosseal muscles, are inserted into the expansion of the extensor tendons upon the back of the first phalanges.

USE.—To assist the flexor tendons in bending the metacarpo-phalangeal articulations.

DISSECTION.—Remove all the preceding muscles and the flexor tendons from the palm of the hand, and the extensor tendons upon the dorsal surface and the interosseal muscles will be brought into view.

The INTEROSSEAL MUSCLES (seven in number, excluding the adductor of the thumb and including the abductor of the index finger) are situated between the metacarpal bones, and are all adductors and abductors of the fingers in reference to the middle line of the hand. They are divided into a palmar and a dorsal group.

The *palmar interosseals*, three in number, are adductors, and belong respectively to the index, ring, and little fingers. Each one originates from the whole length of the corresponding metacarpal bone, and is inserted into the base of the first phalanx.

The *dorsal interosseals* are abductors, and belong to the index, middle, and ring fingers, the middle finger having two, one upon each side. The first dorsal interosseal or abductor of the index finger is the largest of the series, and is sometimes described separately. It is triangular, and has two origins; one from the inner border of the metacarpal bone of the thumb, and the other from the metacarpal bone of the index finger; the fibres converge toward a tendon which is inserted into the base of the first phalanx on its radial side.

VESSELS AND NERVES OF THE SUPERIOR EXTREMITY.

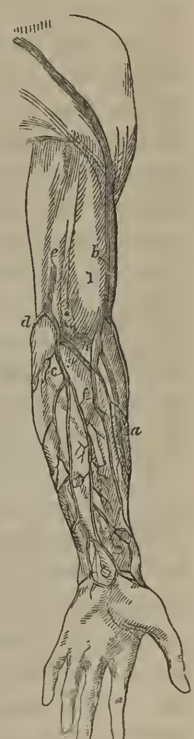
One limb having been reserved for the special study of the vessels and nerves, the student should first direct his attention to the superficial veins and cutaneous nerves.

DISSECTION.—Divide the skin and subcutaneous adipose layer, which latter is generally very thick in females and children, by an incision extending from the top of the shoulder to the bend of the elbow, and thence along the middle of the anterior surface of the forearm to the wrist; intersect this

at each extremity by a circular cut extending entirely around the limb, and proceed to dissect back the two flaps. In performing this dissection, great care is necessary to avoid removing the subcutaneous veins and nerves. If the veins have been previously filled with solid injection, which, however, is a somewhat difficult undertaking, and hence rarely done in the preparation of a subject for ordinary purposes, the dissection will be very much facilitated.

The SUPERFICIAL VEINS of the superior extremity are situated between the subcutaneous layer of adipose tissue and the aponeurosis that covers the muscles. They commence upon the fingers and hand by an infinite number of small ramified branches, which unite upon the anterior aspect of the forearm to form three main trunks, called the radial, median, and ulnar veins. These terminate at the head of the elbow in two trunks, named the basilic and cephalic, which proceed up the arm; the former along its inner, and the latter along its outer aspect, and finally end in the axillary vein. The most common arrangement of these vessels is that described in the following paragraphs, but their varieties are too numerous to mention.

Fig. 243.



Superficial veins of the superior extremity.

The *radial cutaneous vein* (Fig. 243, *a*), situated, as its name indicates, along the radial or external border of the forearm, commences near the wrist by the union of branches from the dorsal surface of the thumb and forefinger. At the bend of the elbow, it unites with the external division of the median vein (*median cephalic*) to form the cephalic vein. Below the elbow, it is in close relation with some branches of the external cutaneous nerve, and opposite the joint, lies near the trunk of the same nerve.

The *cephalic vein* (*b*), formed, as just mentioned, by the union of the radial and median cephalic veins at the outer side of the bend of the elbow, proceeds toward the shoulder, lying at first upon the external border of the biceps muscle, and then in the groove between the deltoid and great pectoral muscles as far as the clavicle, beneath which it bends to join the axillary vein. At its commencement, opposite the elbow, this vessel is in relation with the trunk of the external cuta-

neous nerve, which here perforates the brachial aponeurosis to reach the skin of the forearm.

The *ulnar cutaneous veins*, two in number, an anterior and a posterior, are situated along the internal border of the forearm. The posterior (*d*) commences upon the back of the hand, ascends upon the posterior aspect of the forearm, and at the bend of the elbow comes forward to join the basilic vein. The anterior (*c*) commences in the neighborhood of the wrist, proceeds upward upon the anterior surface of the forearm near its inner or ulnar border, and, having reached the inner part of the bend of the elbow, unites with a branch from the median (*median basilic*) to form the basilic vein.

The *basilic vein* (*e*), formed by the union of the anterior ulnar and median basilic veins, ascends upon the inner side of the biceps muscle, and a short distance above the elbow, varying from half an inch to two or three inches, perforates the brachial aponeurosis, and terminates in one of the accompanying veins of the brachial artery. At other times, it remains distinct and opens into the axillary vein.

The *median vein* (*f*), situated along the middle of the anterior surface of the forearm, commences by the union of a great number of branches in this region, and, a short distance below the elbow, divides into two trunks, which open into the cephalic and basilic veins, and are, consequently, called the median cephalic and median basilic. The *median basilic* (*g*), generally the larger of the two, passes obliquely upward and inward upon the surface of the aponeurotic expansion of the biceps tendon, which separates it from the brachial artery; it is crossed by branches of the internal cutaneous nerve, and presents, therefore, two objections to its selection for the purpose of venesection. The *median cephalic* (*h*) ascends outward to join the cephalic vein, crossing in its course branches of the external cutaneous nerve.

The NERVES met with in dissecting the superficial veins of the arm, are branches of the internal and external cutaneous.

The *internal cutaneous nerve*, the smallest of the divisions of the brachial plexus, descends the arm along the inner side of the biceps muscle, and, having arrived just above the internal condyle of the humerus, perforates the brachial aponeurosis in company with the basilic vein, and divides into two sets of branches; one of these passes downward and outward, sometimes behind, but most commonly in front of the median basilic vein, and is distributed to the skin of the forearm and hand; the other turns round the back of the arm above the elbow, and descends along the ulna to the skin

of the back of the forearm and hand. The filaments that lie in relation with the median basilic vein are liable to be wounded by the lancet in opening this vessel.

The *external cutaneous nerve*, also a branch of the brachial or axillary plexus, descends outward from its origin, perforates the coraco-brachial muscle, passes between the biceps and anterior brachial muscle, and emerges from beneath the brachial aponeurosis opposite the tendon of the biceps; having reached the surface of the aponeurosis, it descends, sometimes in front of, but generally behind the median cephalic vein, proceeds along the external side of the median vein, and divides into an anterior and a posterior branch. The former is distributed to the skin of the back of the forearm as far as the wrist, and the latter to the skin upon the anterior surface of the forearm, some of its filaments extending into the hand.

The SUPERFICIAL LYMPHATICS of the upper extremity are very numerous, and accompany the superficial veins. At the bend of the elbow, some of them pass through a single lymphatic gland situated in front of the internal condyle of the humerus, and terminate in the lymphatic glands placed along the course of the brachial artery; others ascend along with the cephalic vein, and, passing with this vessel between the deltoid and great pectoral muscles, terminate beneath the clavicle in one or more lymphatic glands connected with those at the lower part of the neck.*

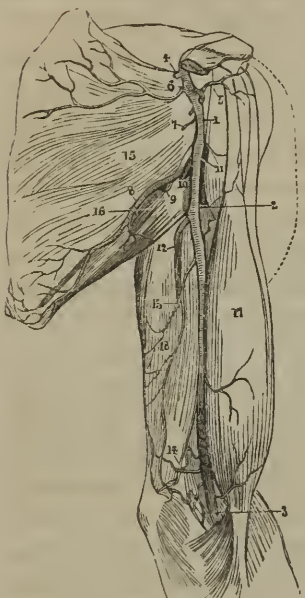
DISSECTION.—Having completed the study of the cutaneous veins and nerves, the student should remove the aponeurosis of the arm, forearm, and hand, and trace the brachial artery, veins, and nerves, to their smaller subdivisions. To do this, he should commence in the axilla, and, taking the artery and nerves separately, follow them down the arm and forearm, dissecting off the areolar tissue by which they are surrounded, and separating the muscles as occasion may require.

THE BRACHIAL OR HUMERAL ARTERY.—The brachial artery, the continuation of the subclavian and axillary, extends from the lower border of the axillary space to the bend of the elbow, immediately below which it divides into the radial and ulnar arteries. Its course, although nearly straight, is not exactly parallel with the humerus, but crosses this bone very obliquely from above downward and forward. It is covered anteriorly by the skin, subcutaneous areolar adipose tis-

* Quain.

sue, and brachial aponeurosis. In the upper half of the arm it is situated between the internal intermuscular septum of the brachial aponeurosis and the internal surface of the coraco-brachial muscle ; at the middle of the arm it reaches the inner side of the biceps, and rests upon the insertion of the coraco-brachial muscle, and thence to the elbow occupies a triangular canal, bounded *externally* by the inner border of the biceps, which slightly overlaps it ; *internally* by the intermuscular septum, which is here attached to the condyloid ridge of the humerus, and separates the vessel from the inner border of the triceps ; and *behind* by the anterior brachial muscle, which separates it from the bone. It is accompanied in its whole course by two companion veins, which are closely connected to it on each side, and by the median nerve, which lies immediately in front of it in the upper part of the arm, but crosses its anterior surface* very obliquely near the middle, and is thence placed upon its internal side. In the lower part of the arm it is also in relation with the basilic vein, which is placed either immediately in front of it or a little to its inner side.

Fig. 244.



Axillary and brachial arteries. 1. Axillary artery, which ends at 2 in the brachial. 2 to 3. Brachial artery. 4, 5, 6, 7. External thoracic arteries. 8. Subscapular artery. 9. Its dorsal branch. 10. Posterior circumflex. 11. Anterior circumflex. 12. Superior profunda. 13. Inferior profunda. 14. Anastomotic artery. 15. Subscapular muscle. 16. Great teres muscle. 17. Biceps muscle. 18. Triceps.

At the bend of the elbow the brachial artery with its companion veins, and with the median nerve in close contact with its inner side, is situated beneath the tendinous expansion of the biceps muscle, which separates it from the median basilic vein. It has the muscles that originate from the internal condyle of the humerus on the one side and the round tendon of the biceps on the other, and rests upon the lower extremity of the anterior brachial muscle. It then sinks into the triangular space bounded internally by the round pronator muscle, and externally by the long supinator, and divides, about an inch below the articulation, into its two terminal branches.

* The median nerve sometimes crosses behind the artery instead of in front.

PECULIARITIES.—On account of the great surgical importance of the brachial artery, its anomalies deserve particular attention.

Occasionally the artery has been observed to deviate from its usual course; instead of occupying the middle line at the bend of the elbow, it is placed in front of the internal condyle of the humerus, whence it passes obliquely outward through the round pronator muscle, to reach the middle of the upper part of the forearm, where it divides into the radial and ulnar arteries. But by far the most common anomaly, occurring about once in every five or six cases,* is a high division of the vessel into its two terminal branches (the radial and ulnar), which may take place at any point between the elbow and axilla. The two vessels thus given off usually descend close together, occupying the ordinary position of the brachial artery, but not unfrequently one or the other pursues a different course. Thus the radial artery, the smaller of the two, often arises from the inner side of the brachial, descends along the corresponding side of the ulnar, and, at the bend of the elbow, crosses the latter beneath the tendinous expansion of the biceps to reach the external border of the forearm. In other instances, the ulnar division leaves the radial in the lower part of the arm, and passes toward the internal condyle lying generally beneath the aponeurosis, but sometimes upon its surface.

BRANCHES OF THE BRACHIAL ARTERY.—The branches of the brachial artery that have received names are the superior profunda, nutritious, inferior profunda, and anastomotic arteries. Besides these, a number of others are given off to the coraco-brachial, biceps, and anterior brachial muscles.

The *superior profunda artery* arises from the brachial just below the border of the great teres muscle, descends backward between the internal and middle heads of the triceps muscle, and winds spirally around the humerus in company with the musculo-spiral nerve to reach the structures in the neighborhood of the external condyle. It is distributed principally to the triceps and the muscles that originate from the external condyle. Occasionally, this vessel is a branch of the subscapular artery and sometimes of the axillary.

The *nutritious artery* is a small twig that comes off about the middle of the arm, enters the nutritious foramen of the humerus, and is distributed to the medullary membrane or endosteum.

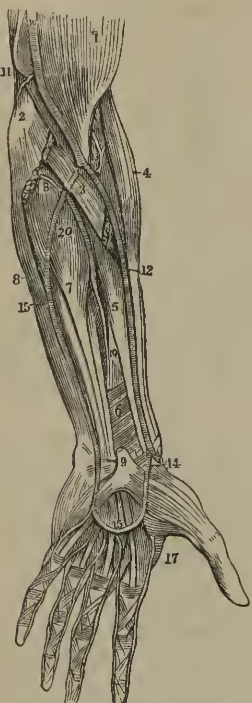
The *inferior profunda artery*, larger than the preceding, immediately below which it originates, descends inward in company with the ulnar nerve, and is distributed to the structures about the inner condyle of the humerus, anastomosing with the recurrent branch of the ulnar. It is not unfrequently a branch of the superior profunda.

The *anastomotic artery* originates from the brachial an inch or two above the elbow-joint. It curves transversely inward across the surface of the anterior brachial muscle, sends branches to the round pronator and triceps muscles, and anastomoses in front with the anterior ulnar recurrent, and upon the posterior surface of the lower extremity of the humerus with the posterior ulnar recurrent and superior profunda.

* Quain.

The ULNAR ARTERY, the larger of the two divisions of the brachial, commences about an inch below the elbow-joint, descends a little inward, forming a slight curve convex internally. Having gained the anterior surface of the ulna above the middle of the forearm, it descends vertically to the wrist, where it crosses the internal extremity of the anterior annular ligament, and curves transversely outward across the palm of the hand, to unite with a branch of the radial in the formation of the superficial palmar arch. In the first part of its course, it is covered by the following muscles, which originate from the internal condyle of the humerus, namely, the round pronator, radio-carpal flexor, middle carpal flexor, and superficial flexor of the fingers, and rests upon the insertion of the anterior brachial and the deep flexor of the fingers. At the point where it becomes vertical, *i. e.* about the junction of the upper with the middle third of the forearm, it is joined from within by the ulnar nerve, and the two, together with the two accompanying veins, descend along the radial border of the ulno-carpal flexor tendon and upon the inner margin of the superficial flexor of the fingers, covered only by the skin, subcutaneous areolar tissue, and the common aponeurosis. In the middle third of the forearm, it lies upon the deep flexor of the fingers, and in the lower third, upon the square pronator. At the wrist, it is also subcutaneous, and rests upon the internal extremity of the anterior annular ligament.

Fig. 245.



The arteries of the forearm. 1. The lower part of the biceps muscle. 2. The inner condyle of the humerus with the humeral origin of the round pronator and radio-carpal flexor muscles cut across. 3. The deep portion of the round pronator muscle. 4. The long supinator muscle. 5. The long flexor of the thumb. 6. The square pronator. 7. The deep flexor of the fingers. 8. The ulno-carpal flexor. 9. The anterior annular ligament—the figure is placed on the tendon of the middle carpal flexor muscle divided close to its insertion. 10. The brachial artery. 11. The great anastomotic artery. 12. The radial artery. 13. The radial recurrent artery. 14. The superficial volar artery. 15. The ulnar artery. 16. Its superficial palmar arch giving digital branches to three fingers and a half. 17. The great artery of the thumb (*magna pollicis*). 18. The posterior ulnar recurrent. 19. The anterior interosseous artery. 20. The posterior interosseous as it is passiug through the interosseous membraue.

Branches.—The named branches of the ulnar artery are the anterior and posterior recurrent, interosseous, and anterior and posterior carpal. Besides these, a number of others are supplied to the muscles with which it is in contact.

The very small *anterior recurrent ulnar artery* arises from the ulnar immediately below its commencement, ascends upon the insertion of the anterior brachial muscle covered by the round pronator, to which it gives branches, and anastomoses with the inferior profunda and anastomotic branches of the brachial.

The *posterior ulnar recurrent artery* is larger than the preceding, and originates immediately below it. It passes upward and inward beneath the superficial muscles that arise from the internal condyle of the humerus, and then between the two heads of the ulno-carpal flexor lying here beneath the ulnar nerve, supplies branches to the various muscles with which it is in contact, also to the elbow-joint and ulnar nerve, and anastomoses upon the olecranon process of the ulna with the anastomotic and superior profunda.

The *common interosseous artery* is a short and tolerably large trunk, which comes from the ulnar artery opposite the bicipital tuberosity of the radius, and divides into an anterior and a posterior branch. The *anterior interosseous artery* descends the forearm upon the anterior surface of the interosseous membrane and between the deep flexor of the fingers and the long flexor of the thumb. Having arrived at the superior border of the square pronator muscle, it perforates the membrane, and is distributed to the back of the wrist, anastomosing here with the carpal branches of the radial and ulnar. The *posterior interosseous artery* passes through the deficiency in the interosseous membrane immediately below the elbow-joint, and is distributed to the muscles upon the back of the forearm; it sends a small recurrent branch to the structures upon the back part of the elbow.

The *anterior and posterior carpal branches* are very small, and supply the corresponding parts of the wrist-joint, anastomosing with the carpal branches of the radial artery.

The superficial palmar artery or arch is the continuation of the ulnar artery. It commences near the internal border of the wrist, passes over the internal attachment of the anterior annular ligament, and is covered here only by the skin, subcutaneous areolar tissue, and small palmar muscle; it then crosses the palm of the hand beneath the palmar aponeurosis and upon the superficial flexor tendons, describing a curve convex toward the fingers, and terminates by uniting with the superficial volar branch of the radial upon the ball of the thumb. In crossing the hand, it is superficial to the divisions of the ulnar and median nerves, and sends off a communicating branch to the deep palmar arch, and numerous branches (*digital arteries*) to the fingers.

The *digital branches*, generally four in number, are given off from the convexity of the palmar arch, and proceed toward the roots of the fingers. The first or most internal runs along the internal or ulnar border of the

little finger; the second divides opposite the fourth metacarpal space into two branches which supply the adjacent borders of the little and ring fingers; the third and fourth divide in the same manner opposite the second and third metacarpal spaces, and supply the adjacent border of the ring and middle and middle and index fingers.

The RADIAL ARTERY, smaller, straighter, and more superficial than the ulnar, descends at first a little obliquely outward to reach the anterior surface of the radius, along the front of which it then proceeds in a vertical direction; having gained the lower extremity of the radius, it turns round the outer border of the wrist, passes through the angle formed by the metacarpal bones of the thumb and index finger, and crosses the deep part of the palmar of the hand to form the deep palmar arch, which is completed by uniting with the communicating branch of the superficial palmar arch. In the first part of its course, the artery is in contact with the tendon of the biceps, rests upon the short supinator muscle, and is overlapped by the fleshy part of the long supinator. About the middle of the forearm it becomes subcutaneous, and lies upon the insertion of the round pronator muscle and between the long supinator and radio-carpal flexor. In the lower part of the forearm, the point at which the pulse is usually examined, it lies almost immediately upon the bone between the tendons of the radio-carpal flexor and long supinator muscles, and is covered only by the common aponeurosis, subcutaneous areolar tissue, and skin.

The radial artery is accompanied by two veins, which are in close connection with it on each side. At the junction of the superior with the middle third of the forearm, it is joined from without by the musculo-spiral or radial nerve, which, however, leaves it before reaching the wrist, and turns round the radius to the back of the limb.

At the lower extremity of the radius, the artery turns outward below the styloid process, passes beneath the tendons of the first two extensors of the thumb, traverses the triangular space between their tendons and that of the extensor of the first phalanx, and may be here felt pulsating, being covered only by the skin and fascia; it next crosses beneath the last named tendon, and enters the palm of the hand through the angle formed by the metacarpal bones of the thumb and index finger, and between the heads of the first interosseous muscle.

BRANCHES.—The branches of the radial artery are numerous and mostly small. Those given off whilst the vessel is upon the forearm,

are the radial recurrent, muscular, anterior carpal and superficial volar.

The *radial recurrent artery* arises just below the elbow-joint, ascends to the parts about the external condyle, and anastomoses with the superior profunda.

The *muscular branches* are small twigs to the muscles upon the anterior and outer part of the forearm.

The *anterior carpal* is a small branch given off opposite the lower extremity of the radius ; it ramifies upon the front of the wrist, and anastomoses with the corresponding branch of the ulnar.

The *superficial volar* or *radio-palmar artery*, generally small, but not unfrequently quite large, arises from the radial immediately below the inferior extremity of the radius, passes downward and inward over the external attachment of the anterior annular ligament, sends branches to the muscles of the thenar eminence, and terminates in the outer extremity of the superficial palmar arch.

The branches given off by the radial while upon the wrist, are the posterior carpal, metacarpal, dorsal arteries of the thumb, and dorsal artery of the index finger.

The *posterior carpal branch* passes across the back of the wrist beneath the radial extensor tendons, anastomoses with the terminal divisions of the anterior interosseous artery, and gives off *dorsal interosseous* twigs to the muscles of the third and fourth metacarpal interspaces.

The *metacarpal branch* descends between the second and third metacarpal bones, and sends twigs to the backs of the index and middle fingers.

The *dorsal arteries of the thumb*, two in number, and very small, come off upon the back of the metacarpal bone, and are distributed to the skin of the back of the thumb.

The *dorsal artery of the index finger*, also very small, runs along the radial side of the back of the index finger.

The branches of the radial upon the palm of the hand are the large artery of the thumb, and the radial branch for the index finger.

The *large artery of the thumb* (*magna pollicis*) arises from the radial immediately after it reaches the palm of the hand, descends along the ulnar border of the metacarpal bone of the thumb, and opposite the head of this bone divides into two branches, which proceed along the opposite borders of the phalanges.

The *radial branch for the index finger* arises close to the preceding and descends to supply the radial border of the index finger, the opposite border being supplied by one of the digital branches of the superficial palmar arch.

The *deep palmar arch*, the continuation of the radial artery in the hand, traverses the palmar surface of the metacarpus from without inward, forming a curve convex forward, and joins the commu-

nicating branch from the superficial palmar arch. It gives off several small branches, the most important of which are the three interosseous, to the muscles of the three metacarpal interspaces.

The Deep Veins.—All the larger subdivisions of the brachial artery have each two companion veins, one upon each side. The veins are contained within the sheaths of the arteries, and are closely adherent; they communicate freely with each other by cross branches, and receive at different points communicating branches from the superficial veins. All eventually terminate in the two brachial veins, which at the margin of the axilla unite to form the axillary vein heretofore described.

The deep lymphatics of the upper extremity are very numerous, and accompany the larger bloodvessels. Some of them, in their course toward the trunk, pass through the lymphatic glands situated along the brachial artery, and all ultimately traverse the lymphatic glands of the axilla.

THE NERVES OF THE SUPERIOR EXTREMITY.

The nerves of the upper extremity are all, with the exception of the humeral branch of the second intercostal nerve, branches of the brachial or axillary plexus, the structure and relations of which have been described in connection with the anatomy of the neck and axilla. They are—

1. The supra-scapular nerve.
2. The sub-scapular nerves.
3. The circumflex nerve.
4. The internal cutaneous nerve.
5. The small internal cutaneous nerve.
6. The external or musculo-cutaneous nerve.
7. The ulnar nerve.
8. The median nerve.
9. The musculo-spiral or radial nerve.

The supra-scapular nerve, the only one of the series that originates above the clavicle, is derived from the fifth cervical nerve. It passes from the root of the neck obliquely outward beneath the anterior border of the trapezius muscle, traverses the supra-scapular

notch, and is distributed to the supra and infra-spinous muscles, furnishing also a small filament to the shoulder-joint.

The SUB-SCAPULAR NERVES (Fig. 213, 15, 16, and 17), generally three in number, arise from the middle of the axillary plexus, descend outward and backward, and are distributed respectively to the sub-scapular, great teres, and latissimus muscles.

The CIRCUMFLEX NERVE arises from the back part of the brachial plexus in common with the musculo-spiral, curves downward and outward beneath the neck of the humerus, in company with the inferior circumflex artery, and is distributed to the outer part of the deltoid muscle and the skin of the upper part of the arm. Before leaving the axilla it sends filaments to the anterior part of the deltoid and skin of the shoulder. Laceration of this nerve is sometimes produced by dislocations of the head of the humerus into the axilla, and is followed by paralysis of the deltoid muscle and consequent inability to elevate the arm.

The INTERNAL CUTANEOUS NERVE, next to the smallest of the divisions of the brachial plexus, arises in common with the ulnar and internal head of the median nerves, descends upon the inner aspect of the arm, about the middle of which it perforates the brachial aponeurosis, and divides into an internal and an external branch. The *internal* and smaller division sends twigs to the integuments about the internal condyle of the humerus, and proceeds along the inner border of the forearm in company with the superficial ulnar veins, giving filaments to the skin as far as the wrist. The *external* divides into a number of branches which pass in front of, and sometimes beneath, the median basilic vein, and is distributed to the skin upon the middle of the anterior surface of the forearm as low as the wrist.

The SMALL INTERNAL CUTANEOUS NERVE arises generally in common with the preceding, crosses the axillary vein obliquely behind, descends upon the inner side of the brachial vessels, communicating with the intercosto-humeral nerve, perforates the brachial aponeurosis about the middle of the arm, and is distributed to the skin of the lower half of the arm on its inner and posterior aspect.

The EXTERNAL CUTANEOUS OR MUSCULO-CUTANEOUS NERVE arises

in common with the external head of the median, descends outward through the coraco-brachial muscle, and then between the biceps and anterior brachial muscle, and perforates the brachial aponeurosis a little above the outer part of the bend of the elbow. It then descends beneath the median cephalic vein and divides into two branches, which are distributed to the skin on the outer border of the forearm, one on its anterior, and the other on its posterior aspect, as far as the wrist. Before becoming cutaneous, this nerve sends branches to the coraco-brachial, biceps, and anterior brachial muscles.

The ULNAR NERVE, one of the larger branches of the brachial plexus, arises in common with the internal cutaneous and inner head of the median, descends along the inner side of the brachial vessels, and about the middle of the arm inclines inward, perforates the internal inter-muscular septum, and reaches the interval between the internal condyle of the humerus and olecranon, in company with the inferior profunda artery, resting upon the internal border of the triceps muscle, and covered only by the skin and brachial aponeurosis. At the elbow, the nerve passes between the two heads of the ulnar flexor muscle of the wrist, and thence descends upon the anterior surface of the forearm near its inner border. In the upper half of the forearm it is covered by the last-mentioned muscle, but in the lower half it is subcutaneous, and lies between the radial border of the tendon of the same muscle and the ulnar artery. Having arrived at the wrist, the nerve continues in company with the ulnar artery, and upon the surface of the anterior annular ligament divides into a superficial and deep palmar branch. The *former* is distributed to the skin of the hypothenar eminence and the opposed borders of the little and ring fingers; and the *latter* to the small muscles of the little finger and to the interosseous muscles.

BRANCHES OF THE ULNAR NERVE.—From the axilla to the elbow the ulnar nerve gives off no branches.

Upon the forearm, it sends filaments to the ulno-carpal flexor, and deep flexor muscle of the fingers, to the elbow and wrist-joints, to the skin of the forearm, and a dorsal branch to the hand. The last-mentioned division is the largest and most interesting; it leaves the main trunk about two inches above the wrist, descends obliquely backward beneath the ulno-carpal flexor tendon, passes along the back of the metacarpus, and divides into two branches, one of which is distributed to the inner side of the little finger, and the other to the opposed sides of the little and ring fingers.

In the palm of the hand, the ulnar nerve divides into a superficial and a deep branch, which are distributed as before mentioned.

The MEDIAN NERVE, larger than the preceding, arises from the brachial plexus by two heads, about an inch in length, which converge and unite upon the external side of the axillary artery. It descends in an almost straight direction to the middle of the elbow, in company with the brachial artery and vein, but crosses very obliquely in front of these vessels, about the middle of the arm to reach their inner side, in which relation it enters the forearm between the two heads of the round pronator muscle. Below the elbow it proceeds along the middle of the anterior region of the forearm, between the superficial and deep flexor muscles of the fingers, to within a short distance of the wrist, where it is placed between the tendons of the radio-carpal and superficial flexor of the fingers, and is covered only by the common aponeurosis and skin. It then enters the palm of the hand beneath the anterior annular ligament and palmar aponeurosis, resting upon the superficial flexor tendons, and divides into two parts, one of which supplies the thumb and index finger, and the other the middle finger and the contiguous surfaces of the index and ring fingers.

BRANCHES OF THE MEDIAN NERVE.—From the axilla to the elbow the median nerve gives off no branches. In the forearm it supplies all the pronator and flexor muscles, except the radio-carpal flexor and part of the deep flexor of the fingers, and sends a single filament to the skin of the palm of the hand. The largest of the muscular branches (anterior interosseous nerve) accompanies the anterior interosseous artery, and is distributed to the long flexor of the thumb, deep flexor of the fingers, and square pronator. The cutaneous branch perforates the fascia immediately above the annular ligament, and ends in the skin about the middle of the palm of the hand.

After reaching the palm of the hand, beneath the annular ligament and palmar aponeurosis, the median nerve divides, as before mentioned, into an internal and an external branch. The external division supplies the abductor, opponens, and short flexor muscles of the thumb, and sends branches (digital nerves) to the skin of the thumb and index finger. The internal supplies both sides of the middle finger and the adjacent borders of the index and ring fingers.

The *digital nerves*, derived from the two divisions of the median, are five in number, and are distributed to the sides of the thumb, index, and middle fingers, and the radial side of the ring finger, the ulnar side of the last, and the two sides of the little finger being supplied by the digital branches of the ulnar. Having gained the angles between the fingers, these nerves lie immediately under the skin, having emerged from beneath the palmar fascia, whence they proceed, the *first* and *second* to the sides of the thumb, and the *third* to the radial side of the index finger; the *fourth* bifurcates, and supplies the contiguous surfaces of the index and middle fingers, and the *fifth* is distributed in like manner to the adjacent borders of the middle and ring fingers.

The MUSCULO-SPIRAL OR RADIAL NERVE, the largest of the branches of the brachial plexus, descends the upper part of the arm behind the axillary and brachial vessels, enters between the internal and middle heads of the triceps muscle, winds in a spiral manner around the back of the humerus in company with the superior profunda artery, and makes its appearance at the outer part of the arm immediately above the elbow, between the long supinator and anterior brachial muscles. In this relation, it reaches the external condyle of the humerus, gives off here the posterior interosseous nerve, and proceeds down the front of the forearm near its outer side, still covered by the long supinator muscle. In the upper third of the forearm it joins on its outer side the radial artery, and about three inches above the wrist turns outward beneath the long supinator muscle, to reach the back of the radius, and divides into two branches, which are distributed to the skin upon the dorsal surface of the thumb and first two fingers.

BRANCHES OF THE MUSCULO-SPIRAL OR RADIAL NERVE.—The branches given off from the radial nerve in the arm are muscular and cutaneous. The muscular branches are numerous, and supply the triceps, anconeus, long supinator, and long radio-carpal extensor. · The cutaneous branches are, 1, the *internal*, which comes off in the internal and upper part of the arm, and is distributed to the skin on the back of the arm. 2. The *superior external* arises in the middle and outer part of the arm, descends along the cephalic vein, and is distributed to the skin of the lower half of the arm on its anterior aspect. 3. The *lower external* perforates the brachial aponeurosis upon the outer aspect of the arm near its middle, passes to the forearm over the external condyle of the humerus, and turns round the outer border of the forearm, about midway between the elbow and wrist, to reach its posterior surface; it is distributed to the skin upon the back of the lower half of the arm and upon the back of the forearm.

The *Posterior Interosseous Nerve* is the proper continuation of the main trunk of the musculo-spiral, as far as regards its size. It arises opposite the external condyle of the humerus, turns outward to the back of the forearm, through the fibres of the short supinator muscle, and reaches the posterior surface of the interosseous membrane by passing between the superficial and deep extensor muscles. It then descends in company with the posterior interosseous artery to the wrist, and gives branches to all the supinator and extensor muscles of the wrist and fingers, except the long supinator and long radio-carpal extensor.

Upon the lower back part of the forearm, the radial nerve divides, as before mentioned, into two parts. The *external* division, very small, is distributed to the skin on the radial side of the thumb. The *internal* division reaches the posterior surface of the hand, and divides into four dorsal digital nerves which supply the ulnar side of the thumb, both sides of the index and middle fingers, and the radial side of the ring finger, corresponding thus to the distribution of the digital branches of the median nerve.

THE EYE AND ITS APPENDAGES.

THE globe or ball of the eye, the essential part of the visual apparatus, lies within the bony orbit, where it is protected and assisted in the proper performance of its functions by a number of accessory structures. These appendages, called technically the *tutamina oculi*, are the eyebrows, the eyelids, the lachrymal apparatus, and the special muscles by which the organ is moved. The orbits having been already described in connection with the bones of the face, the appendages should be now considered.

APPENDAGES OF THE EYE.

The EYEBROWS, or superciliæ, are the two hairy arches situated above the eyes, and immediately over the superciliary prominences of the frontal bone. Their general appearance and their differences in different individuals are too familiar to require description. They are peculiar to man, and their use is said to be to assist in protecting the eye from too much light, and also from dust and perspiration; but the probability is, they are intended partly for ornament and partly to express certain emotions of the mind. For this end they are provided with a special muscle, called the corrugator, and are connected also with the occipito-frontal and orbicular muscles.

The EYELIDS (*palpebræ*) are aptly compared to movable curtains placed in front of each orbit to protect the eye from injury, and, by their closure, to shut out the light. They are transversely elliptical in shape, but the superior is much the broader, and provided with a special muscle (*elevator of the upper eyelid*) for its elevation. They are separated from each other by a transverse slit, called the *palpebral fissure*, and at its extremities they join together at an acute

angle. The length of the palpebral fissure varies in different individuals, but is always less than the transverse diameter of the orbit, the union between the external extremities of the lids occurring two or three lines internal to the external margin of the orbit; so that, in the operation for removal of the ball of the eye, an incision is necessary. Of the two angles (called, technically, the *canthi*), formed by the union of the lids, the *external* (external canthus) is more acute, and lies directly in contact with the ball of the eye; the internal is long and narrow, situated upon a plane somewhat below the other, and occupied by the lachrymal caruncle. The free margins of the lids are thick and flat in the greater part of their extent, but at the internal canthus they are rounded off and curved. The point of union between the straight and curved portions is marked upon each lid by a small conical elevation, called the *papilla*, upon whose summit is the minute orifice or punctum of the corresponding lachrymal duct. When the lids are closed, their free margins are in accurate contact, the whole length between the lachrymal papilla and the external canthus; but, owing to the greater breadth of the superior lid, the line of union is below the transverse axis of the eye, and forms a very slight curve, with its convexity presenting downward and forward.

Structure.—Each lid is composed of skin, areolar tissue, muscular fibres, fibro-cartilage, sebaceous follicles, and mucous membrane.

The *skin*, or cutaneous layer, is very thin and delicate, and continuous at the free edge of the lid with the mucous membrane—the conjunctiva. At the line of union between the two are the short stiff hairs, called the eyelashes, which are longer and more numerous on the upper lid than on the lower, and are entirely wanting on both lids internal to the lachrymal papillæ. The number of these hairs is variable; but, as a general rule, they form but one row on each lid. Their direction is curved, the superior convex below, and the inferior in an opposite direction, which is doubtless intended to prevent their interfering with each other when the lids are closed.

Beneath the skin is a layer of fine, loose *areolar tissue*, which, like that upon the penis, lungs, and some other parts of the body, contains no fat cells, and is hence never the seat of adipose deposit.

Next in order are the pale scattered fibres of the palpebral portion of the *orbicular muscle*, and beneath this the tarsal cartilages.

The *tarsal cartilages* are two thin plates of fibro-cartilage, which give elasticity and firmness to the lids, and prevent them from puckering or curling when the orbicular muscle contracts. The superior, the larger of the two, is semi-elliptical; the inferior is in the form of a narrow strip. Their contiguous margins are thick, correspond to the free margins of the lids, and contain the roots of the eyelashes. Their orbital margins are thin, and continued by a fibrous membrane to the periosteum of the corresponding borders of the orbit. The upper edge of the superior cartilage gives attachment also to the expanded tendon of the elevator muscle of the upper lid. The anterior surface of each is covered by the orbicular muscle; the posterior is lined by the palpebral portion of the conjunctiva, and marked by numerous vertical grooves for the accommodation of the Meibomian follicles.

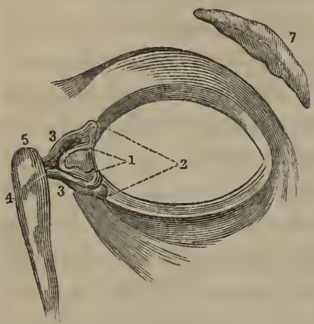
The *Meibomian follicles* belong to the class of sebaceous glands; they are imbedded in the posterior surface of the tarsal cartilages external to the palpebral conjunctiva, through which they may be seen as yellow vertical lines of unequal length, and so small as often to escape observation in an ordinary examination. Their number varies from fifteen to twenty on each lid. They consist of minute and slightly tortuous tubes, lined by a scaly epithelium, and terminating in one or more blind extremities. Their orifices may be found, by the aid of a pocket-glass, along the free margins of the lids behind the roots of the eyelashes, where they form a single row from the external canthus to the lachrymal papilla. They secrete a yellow waxy substance, the use of which seems to be to prevent the tears from running over the margins of the lids.

The *lachrymal caruncle* is a small, red, oval body, situated in the inner canthus of the eye. It consists of a group of sebaceous follicles, covered by the mucous membrane, and often has a few short fine hairs growing from its surface.

The CONJUNCTIVA (*tunica adnata*) is a mucous membrane, which lines the posterior surface of the eyelids, and covers the anterior surface of the globe of the eye. It consists, therefore, of a palpebral and an ocular portion. The *palpebral portion* is thick and vascular, closely connected to the internal surface of the tarsal cartilages and Meibomian follicles, and continuous at the free margins of the lids with the skin and with the lining mucous membrane of the Meibomian follicles and lachrymal ducts. Its free surface is said to be covered

by numerous fine papillæ,* and their enlargement in chronic conjunctivitis gives rise to the well-known granular appearance noticed only upon this portion of the membrane. The *ocular portion* is thin and transparent, and continuous with the preceding opposite the margins of the orbit, whence it may be very readily traced over the anterior part of the sclerotic coat of the eyeball, to which it is connected by a loose fibro-areolar tissue, called the *ocular fascia.* At the circumference of the cornea, or clear part of the eye, the corium or fibro-vascular layer of the membrane ceases, but the epithelium is continued over the whole of the anterior surface of this structure. At the inner canthus of the eye the conjunctiva forms a slight vertical fold, called, from its shape, the *semilunar fold* (*plica semilunaris*), which is a rudimentary analogue of the third eyelid (*membrana nictitans*) of some of the inferior animals.

Fig. 246.



Anterior view of the lachrymal apparatus. At the inner canthus are the puncta, 1, and canaliculi, 2, with the caruncula between them. The lachrymal sac forms the upper third of the vertical tube, 5, 6, and the nasal duct the remainder. These parts are separated within by a fold of the lining membrane. (After Sœmmering.)

The *epithelium* of the conjunctiva belongs to the tessellate variety. Its *vessels* are derived from the palpebral and lachrymal arteries, and from the muscular and anterior ciliary branches of the ophthalmic artery. The *veins* follow the same course as the arteries. The *nerves* are branches of the fifth pair.

The LACHRYMAL APPARATUS consists of a glandular organ (lachrymal gland) for the secretion of the tears, two small canals (lachrymal canals), by which the fluid is taken from the surface of the eye, a sac (lachrymal sac) for its reception, and a single canal (nasal duct), by which it is carried into the nose.

The *lachrymal gland* (Fig. 246, 7) is a small semi-ovoidal body, of a light pinkish-white color, and about the size of an almond kernel, situated upon the outer and upper surface of the globe of the eye, in a superficial depression, just within the external angular process of the frontal bone. It is surrounded by an imperfect cap-

* Sharpey and Quain.

sule of condensed areolar tissue, and consists of two distinct and unequal parts or lobes, the larger of which corresponds to the above-mentioned fossa; the smaller division (called the palpebral lobe) extends down upon the upper back part of the superior eyelid, and is in contact with the conjunctiva. Like other compound glands, it consists of a number of small lobules held together by areolar tissue and vessels, and is provided with eight or ten very minute excretory ducts, which proceed from the inferior border of the organ to open upon the free surface of the conjunctiva, just where this membrane is reflected from the back of the upper eyelid to the globe of the eye. The existence of these ducts was for a long time denied by many of the older anatomists, but they can be readily demonstrated in the human subject by spreading ink, or some other colored fluid, upon the surface of the conjunctiva in the situation of their orifices; in some of the larger mammalia, they may be seen with the naked eye, without resorting to any such process. The office of the lachrymal gland is to secrete the tears which flow out upon the surface of the conjunctiva and serve to keep this membrane moist.

The artery of the lachrymal gland is a branch of the ophthalmic. Its nervous filaments, which are very few and small, are derived from the first or ophthalmic division of the fifth pair.

The *lachrymal canals* (Fig. 246, 3, 3), two in number, and very small, are situated in the margins of the lids at the inner canthus. They each commence by a minute orifice (*punctum*) upon the summit of the corresponding lachrymal papilla, and take at first, for a very short distance, a vertical course, the superior upward and the inferior downward, and at the base of the papillæ turn abruptly inward, and proceed convergingly toward the root of the nose, where they perforate the outer ball of the nasal sac, and open very near each other upon its inner surface. Although their caliber is very small, their walls are very dense and elastic, and lined by a mucous membrane, continuous at their orifices or puncta with the conjunctiva. Their direction should be particularly noticed by the student, as it sometimes becomes necessary to introduce a probe through them into the lachrymal sac.

Connected with the lachrymal canals is a small muscle called the tarsal tensor, or Horner's muscle, which may be exposed in the following manner:—

Dissection.—Detach the eyelids from the margins of the orbit except at the inner canthus, turn them over the nose, and make them tense by means of a double hook; then dissect the conjunctiva and a subjacent layer of fas-

cia from the posterior face of the inner extremity of each lid, and the muscle will be brought into view.

The *tarsal tensor* (*tensor tarsi*), or *Horner's* muscle*, is a small dependency of the orbicular muscle of the eye. It arises from the ridge of the unguiform bone behind the lachrymal groove, passes transversely outward, and divides into two slips, which are inserted respectively into the superior and inferior lachrymal canals near the puncta. Its use, according to its discoverer, is to dilate the lachrymal sac, and to keep the eyelids applied to the surface of the ball of the eye.

The *lachrymal sac* (Fig. 246, 5) is the upper, dilated, blind extremity of the nasal duct. It occupies the lachrymal groove formed by the nasal process of the superior maxillary and the lachrymal or unguiform bone at the anterior extremity of the inner wall of the orbit, and is crossed in front and a little above the middle by the tendon of the orbicular muscle. It is about a fifth of an inch in length and breadth, and consists of a strong fibrous envelop, lined by a mucous membrane, continuous through the lachrymal canals with the conjunctiva, and through the nasal duct with the lining membrane of the nose.

The *nasal duct* occupies the bony canal leading from the lachrymal groove to the lower meatus of the nose. It is about a half or three-fifths of an inch in length, somewhat narrower at its middle than at either extremity, and descends from above slightly outward and backward. Like the lachrymal sac, it consists of a fibrous and a mucous coat, the former closely adherent to the walls of the bony canal and the latter continuous above with the lining membrane of the sac and conjunctiva, and below with the mucous membrane of the nose. The lower orifice of the duct is situated close under the anterior extremity of the inferior spongy bone, and is guarded by an imperfect valve formed by a duplication of the pituitary membrane. It is this fold, or valve, that offers the greatest obstacle to the introduction of an instrument into the canal from below.

* Named from its discoverer, the late Professor Horner, of the University of Pennsylvania.

MUSCLES OF THE EYE.

Each eye has appropriated to it ten separate muscles, six of which belong to the globe or ball of the eye, and the remaining four to the appendages. Three of the latter, namely, the orbicular, corrugator of the eyebrow, and tarsal tensor, have been already described; the remaining one of this set, the elevator of the upper eyelid, and the six proper muscles of the organ, are contained within the orbit, and should now be examined.

Dissection.—Remove the roof and external wall of the orbit by means of two cuts with the saw, meeting behind within a short distance of the optic foramen, taking care to leave a small portion of the roof near the internal angular process of the frontal bone, to show the attachment of the cartilaginous pulley belonging to the superior oblique muscle. This done, proceed with great care to dissect the areolar and adipose tissue from the surface of the muscles and between them.

The elevator muscle of the upper eyelid (*levator palpebræ superioris*, Fig. 247, 1), broad in front and narrow behind, arises from the superior margin of the optic foramen, passes forward and a little upward close beneath the roof of the orbit, gradually expanding, and, having reached the orbital arch, ends in a broad, thin tendon, which curves over the superior surface of the ball of the eye, and is inserted into the whole length of the upper edge of the superior tarsal cartilage.

Use.—To elevate the upper eyelid, drawing it at the same time beneath the orbital arch.

Relations.—The superior surface of the muscle is in contact with the roof of the orbit, and is crossed obliquely behind by the ophthalmic nerve; its inferior surface rests upon the superior straight muscle of the eye.

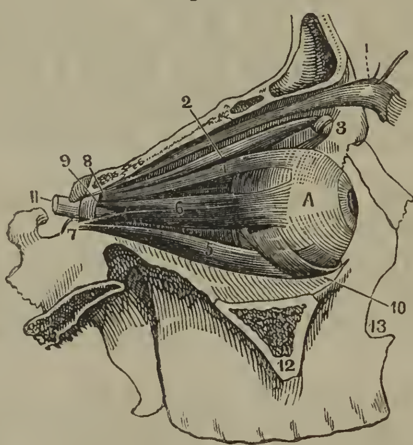
Relaxation of this muscle, as in sleep or as an effect of paralysis, is attended with passive closure of the lids, but active occlusion depends upon contraction of the orbicular muscle. The lower lid is not provided with a corresponding muscle, but is depressed partly by the natural elasticity of the parts, the orbicular being relaxed, and partly by a slight protrusion of the ball of the eye when the upper lid is elevated.

Of the six muscles proper to the ball of the eye, four are called *straight*, and two *oblique*.

The STRAIGHT MUSCLES OF THE EYE are all flat and ribbon-like. They originate by pointed extremities from the apex of the orbit or its immediate vicinity, whence they diverge as they proceed forward, curve over the globe of the eye, and are inserted by broad, thin tendons into the sclerotic coat, a short distance from the circumference of the cornea. Although so much alike, they differ somewhat in length, size, and obliquity; thus, the superior is the thinnest and narrowest; the external, the longest and most slanting; and the internal, the shortest and thickest, and almost perfectly straight. At their insertions, the tendons spread out in front of the sclerotic; and, being connected at their contiguous borders by means of the ocular fascia, form a continuous aponeurotic membrane, which is sometimes, but improperly, called the *albugineous tunic.*

The SUPERIOR STRAIGHT MUSCLE (Fig. 247, 4, *rectus superior*, *levator oculi*) originates by short tendinous fibres from the upper margin of the optic foramen and from the sheath of the optic nerve, passes forward and a little upward and outward, becomes about half an inch broad, and ends in an aponeurotic tendon, which curves over

Fig. 247.



Muscles of the eyeball. A. Ball of the eye. 1. Elevator of the upper lid. 2. Superior oblique or trochlear muscle. 3. Pulley of the same. 4. Superior straight muscle. 5. Inferior straight muscle. 6. External straight muscle. 7. Ligament of Zinn. 8. Origin of the superior oblique muscle. 9. Origin of the external straight muscle. 10. Inferior oblique muscle. 11. Optic nerve. 12. Malar bone divided. 13. Superior maxillary bone.

the superior part of the globe of the eye, and is inserted into the sclerotic coat about three or four lines from the circumference of the cornea.

Relations.—Superiorly, with the elevator of the upper eyelid, a layer of fascia intervening; inferiorly, with the optic nerve, ophthalmic artery, nasal nerve, and the reflected portion of the superior oblique muscle, from all of which it is separated by processes of fascia and by more or less adipose tissue.

The inferior straight muscle (Fig. 247, 5, *rectus inferior, depressor oculi*) arises, in common with the internal and external straight muscles, from the lower part of a semicircular tendinous band, called the ligament of Zinn, that surrounds the lower half of the optic foramen; it passes forward and a little downward, curves over the lower surface of the ball of the eye, and is inserted by a broad, thin tendon into the sclerotic coat opposite to the preceding, and about the same distance from the cornea.

Relations.—Superiorly, with the optic nerve, the ball of the eye, and the adipose tissue of the orbit; inferiorly, with the floor of the orbit, from which it is separated in front by the inferior oblique muscle.

The internal straight muscle (*rectus internus, adductor oculi*), the shortest and thickest of the group, arises in common with the two preceding from the semicircular ligament, and from the optic sheath. It passes horizontally forward, and ends in an expanded tendon, which is inserted into the sclerotic coat about three lines from the inner border of the cornea.

Relations.—By its internal surface, with the inner wall of the orbit; and by its external, with the optic nerve, intermuscular tissue, and eyeball. Along its upper border may also be observed the anterior and posterior ethmoidal vessels and the nasal and supra-orbital nerve.

The external straight muscle (Fig. 247, 6, *rectus externus, abductor oculi*), the longest and most oblique of the group, arises by two heads, one from the semicircular ligament, and the other in common with the superior straight muscle from the margin of the optic foramen. It passes forward and outward, and is inserted like the others by a broad tendon into the sclerotic coat, about four lines from the cornea.

Relations.—Between the two heads of this muscle, the third and sixth nerves and the nasal branch of the fifth enter the cavity of the orbit. Its internal surface is in contact with the intermus-

cular adipose tissue, the ophthalmic artery and vein, the optic, third, nasal, and sixth nerves, and the ciliary ganglion and branches. Its external surface is in relation with the external wall of the orbit, and, at the anterior extremity, with the lachrymal gland and ducts.

Actions.—The straight muscles of the eye turn the cornea or clear part of the organ in the direction of the particular muscle brought into action. When two adjacent ones contract at the same time, rotation is in the direction of the diagonal of the two forces; and when they all contract at once, they retract the organ slightly in the direction of the axis of the orbit.

The oblique muscles of the eye are two in number, and distinguished by their relative position, one being situated above, the other below the eyeball.

The superior oblique or trochlear muscle (Fig. 247, 2, *obliquus superior*), long and slender, arises by a delicate tendon from the margin of the optic foramen, between the internal and superior straight muscles and from the sheath of the optic nerve, and proceeds forward and a little upward and inward, toward the internal angular process of the frontal bone; behind this process it forms a small round tendon, which passes through a fibro-cartilaginous pulley or loop, attached to a small depression upon the surface of the bone in this situation, and provided with a synovial bursa; it then turns downward, backward, and outward, between the anterior third of the superior straight muscle, to be inserted into the sclerotic coat between the superior and external muscles, and about midway between the cornea and the entrance of the optic nerve.

The inferior oblique muscle (Fig. 247, 10) is situated in the fore part of the orbit, below the globe of the eye. It arises by a short rounded tendon from the margin of the superior maxillary bone, between the infra-orbital foramen and lachrymal groove, and forms a thin fleshy fascicle, which passes outward and backward in a curved manner, beneath the globe of the eye and the anterior extremity of the inferior straight muscle, and is inserted by a tendinous expansion immediately below the insertion of the superior oblique.

Actions.—The superior oblique acts from the point of its reflection, and is generally considered to rotate the eyeball upon its antero-posterior axis, draw it slightly forward, and turn the cornea downward

and outward. The inferior oblique also rotates the organ upon its antero-posterior axis, but in an opposite direction, assists the superior in drawing it forward, and turns the cornea upward and inward.

The Ocular Fascia.—In dissecting the muscles of the eye, the student should not neglect to notice the fascia by which they are surrounded and separated from one another. It is a loose, thin, but tolerably consistent membrane, which forms a common investment for all the structures behind the globe of the eye, and is prolonged forward over the tendons of the muscles to the tarsal cartilages, and upon the anterior part of the sclerotic coat, where it forms the medium of attachment between this tunic and the reflected portion of the conjunctiva. It not only forms a common covering for the muscles, but forms separate and distinct sheaths for them, which are continued as far as their insertion, and then attached to the sclerotic coat. This fact should be borne in mind in operating for strabismus, for, owing to this arrangement, if only the muscle upon which the obliquity of the eye depends is divided, the deformity may still remain unrelieved.

THE GLOBE OF THE EYE.

The globe or ball of the eye is almost regularly spherical in shape, but, viewed in profile, presents a somewhat greater convexity in front, corresponding to the situation of the cornea. In point of size it is not subject to great variety, and measures in general about eleven lines in its antero-posterior diameter, and ten in its vertical and transverse, the greater length of the antero-posterior being dependent upon the projection of the cornea. It is situated in the fore part of the orbit, occupying, however, on account of its relatively small size, but a small part of this cavity, and is held in its position by the conjunctiva, muscles, and other structures attached to its exterior, but more particularly by the masses of adipose tissue which fill the interspaces of the muscles, vessels, and nerves behind. When this tissue is absorbed, which occurs in protracted fevers and other wasting diseases, the eye sinks within the orbit, and gives to the part that unpleasant hollow appearance so familiar to every one.

In a philosophical point of view, the eye is a complicated dioptric instrument. It consists essentially of a sentient nervous membrane, placed in a dark chamber, with a single aperture closed by a trans-

parent structure for the admission of the rays of light. Anatomically considered, it is composed of a series of superimposed layers, called tunics or coats, inclosing a number of fluids or humors, and a movable diaphragm called the iris. The external tunic or coat consists of two parts, one called the *sclerotic coat* and the other the *cornea*. Within the sclerotic is the *choroid coat*, and the *retina* or nervous membrane is next. The humors are the *aqueous*, surrounded in part by a special membrane, the *crystalline lens*, with its inclosing capsule, and the *vitreous humor*, also provided with a special secreting membrane named the *hyaloid*. The *iris* is usually enumerated among the tunics, but is entirely different in its structure and uses, as will be presently seen.

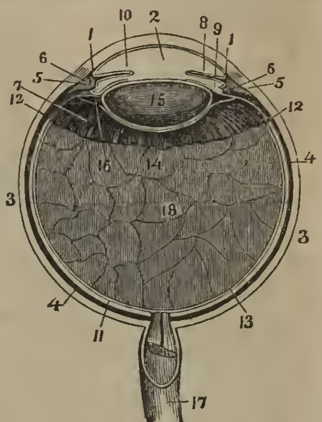
Dissection.—For most purposes, the eyes of some of the larger inferior animals answer as well as those of the human subject, and, being readily procured in a fresh state, and more easily dissected, the student is advised to employ them until he shall have gained sufficient knowledge of the general structure of the organ, and skill in manipulation, to enable him to make a proper examination of the human eye. Having obtained, therefore, a number of ox or sheep's eyes, let him commence by clipping off, with a pair of sharp scissors, all the muscles, fat, and areolar tissue from the circumference of the globe, so as to expose the sclerotic coat and cornea. Having treated one or two eyes in this way, he may divide one in an antero-posterior direction, and turn out its contents for the purpose of examining the internal surface of these structures.

The sclerotic coat is a dense, white, fibrous membrane, upon which the strength and form of the eye depend. It forms a kind of shell or case for the protection of the delicate parts within, and constitutes about four-fifths of a regular sphere, the deficiency corresponding to the situation of the transparent cornea. It is perforated behind about a line and a half to the inner side of the antero-posterior axis of the eye by the optic nerve, and is continuous here with the fibrous sheath which this nerve receives from the dura mater. Its external surface is of a pearly white glistening appearance, covered in front by the conjunctiva and the expanded tendons of the straight muscles, and in contact behind with the adipose substance that fills this part of the orbit, a loose areolar tissue intervening. Its internal surface is in relation, throughout its whole extent, with the choroid coat, from the black pigment of which it receives a light brownish color; but when this is washed off, the surface presents a smooth, white, glossy appearance.

The sclerotic coat is thickest behind, in the vicinity of the entrance of the optic nerve, from which point it becomes gradually

thinner toward its continuation with the cornea. In point of structure it is a true fibrous membrane, its fibres interlacing in every direction. It is perforated at various points behind by numerous nerves and vessels on their way to the choroid coat and iris, but is itself almost devoid of vascularity and sensibility in the healthy state.

Fig. 248.



Horizontal section of the eye. 1, 1. The cornea, fitted into the sclerotic. 2. Its posterior elastic lamina, forming the anterior parietes of the chamber of the aqueous humor. 3, 3. Sclerotic. 4. 4. Choroid coat. 5, 5. Ciliary ring or ligament. 6. Its internal surface, corresponding to the ciliary processes. 7. Ciliary body, or corona ciliaris of the choroid coat. 8. Iris. 9. Posterior chamber of the aqueous humor. 11. Retina. 12, 12. Termination of the retina, according to Cruveilhier and others, at the posterior extremities of the ciliary processes of the vitreous body. 12. Vitreous humor. 13. Hyaloid tunic, one layer of which passes behind, 14, and the other in front of the crystalline lens. 15. Lens. 16. Canal of Petit. 17. Optic nerve, invested by a sheath from the dura mater. 18. Vitreous humor.

The CORNEA is a transparent concavo-convex disk, of firm elastic structure, accurately fitted to the deficiency in the sclerotic coat in the forepart of the eye; but, being the segment of a smaller sphere, it renders this part of the organ a little more prominent. The degree of its convexity varies in different individuals and at different ages, being generally greatest in near-sighted persons and children. Its outline or margin is almost circular, but slightly elongated in a transverse direction; its thickness is nearly the same at all points. The anterior surface of the cornea is covered by a continuation of the epithelium of the conjunctiva; its posterior or concave surface forms the anterior wall of the anterior chamber of the eye, and is in contact with the aqueous humor.

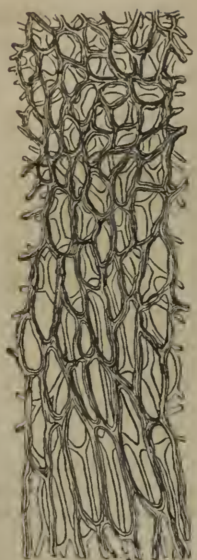
STRUCTURE.—The cornea consists of four separate structures, which, commencing from without, are, the conjunctival epithelium, the cornea proper, the elastic lamina, and the posterior epithelium.

The anterior or conjunctival epithelium has been already described.

The cornea proper constitutes by far the greater part of the thickness of the membrane. By maceration and careful dissection, it may be separated into several layers, which are connected together by delicate areolar tissue, and consist, under the microscope, of soft indistinct fibres, continuous with, and, according to Hassal, Todd and Bowman, similar in many respects to those of the sclerotic coat.

The elastic lamina, or third layer of the cornea, is a thin homogeneous membrane, readily recognized with the naked eye, and but slightly attached to the cornea proper. It preserves its transparency even in boiling water

Fig. 249.



Section of the sclerotic and cornea at the junction between the two, magnified 54 diameters. In the sclerotic, the spaces between the fibrous tissue are seen to be more or less rounded, while in the cornea, they are elongated and tubular. (Hassal.)

and acetic acid, and although it may be torn in any direction, is so hard that it is bitten through with difficulty.* It is commonly called the membrane of Demours.

The posterior epithelium lines the internal surface of the elastic lamina, and is in contact with the aqueous humor. It is exceedingly delicate, belongs to the tessellate or pavement variety, and although supposed to be concerned in the secretion of the aqueous humor, does not extend beyond the circumference of the cornea.

Anatomists have almost universally failed to demonstrate the presence of bloodvessels in the healthy cornea, but from the fact that this structure, when divided, is known to unite readily by the adhesive process, and is moreover subject to deposition of lymph between its laminæ and to ulceration in all its forms and stages, its non-vascularity has not been generally admitted. Two sets of vessels surround its margin, and anastomose here in the form of an intricate vascular zone, the superficial continuous with those of the conjunctiva, and the deep with the short ciliary arteries which penetrate the sclerotic in the immediate vicinity to reach the iris. From the margin of this zone, vessels are said to have been recently demonstrated by Prof. Gaddi to enter the cornea and penetrate between its laminæ.

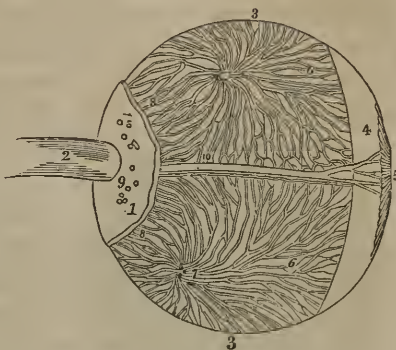
No nerves have ever been traced into the cornea, but they no doubt exist, for its conjunctival layer is one of the most highly sensitive structures in the body.

Dissection to expose the Choroid Coat.—Take an eye that has been perfectly freed from muscles, areolar tissue, fat, &c. (one that is two or three days old is preferable), and, having made a small opening with a sharp scalpel, through the sclerotic coat, two or three lines from the cornea, introduce a pair of blunt-pointed scissors, and by successive short cuts divide the sclerotic in a circular manner entirely around the organ. From different parts of this circular incision three or four others may be made in the direction of the optic nerve, when by a little care the several sections may be separately turned back, the connecting areolar tissue and the vessels and nerves that pass from one membrane to the other being divided as occasion requires This dissection is best performed under water.

* Hassal.

The CHOROID COAT is a vascular membrane of a dark-brown or chocolate color. It corresponds to the whole extent of the inner surface of the sclerotic, and, near the junction of this latter membrane with the cornea, is connected to a circular band of white substance, called the *ciliary ligament*, whence it is turned inward toward the crystalline lens, forming a folded flattened ring named the *ciliary body*.

Fig. 250.



A dissection of the eyeball, showing its second tunic and the mode of distribution of the varicose veins of the choroid. (After Arnold.) 1. Part of the sclerotic coat. 2. The optic nerve. 3, 3. The choroid coat. 4. The ciliary ligament. 5. The iris. 6, 6. The varicose veins. 7, 7. The trunks of the varicose veins at the point where they have pierced the sclerotica. 8, 8. The posterior ciliary veins, which enter the eyeball in company with the posterior ciliary arteries, by piercing the sclerotic at 9. 10. One of the long ciliary arteries, accompanied by a long ciliary vein.

The outer surface of the choroid coat is rough and flocculent, and connected to the inner surface of the sclerotic by means of a loose areolar tissue, through which the ciliary vessels and nerves, having perforated the fibrous membrane, proceed to reach the iris. The internal surface lies in contact with the retina as far forward as the ciliary ligament, beyond which it rests upon the hyaloid membrane; it is smooth, villous, bluish-brown in color, and in some of the inferior animals, the ox for example, presents a most beautiful brilliant metallic lustre.

STRUCTURE.—The choroid coat consists of the ramifications of minute veins and arteries, held together by fibro-areolar tissue, and of coloring matter, called black pigment. The *bloodvessels* are usually described as forming two layers, which, however, cannot be dissected apart. The external layer consists mostly of veins, which, when injected and the black pigment carefully washed off by means of a camel-hair brush, will be found arranged in most beautiful whorls, and are hence called the *vorticose veins;* they converge to form four or five principal trunks, which perforate the sclerotic coat and terminate in the ophthalmic vein. The inner layer is made up of ramified arterial twigs closely interwoven, and connected to the preceding by areolar tissue.

The *black pigment* exists in greatest abundance upon the inner surface of the membrane. In this situation its cells are of a hexagonal or pentagonal form (see Fig. 31), and arranged into a distinct pavement layer, which is much more evident in some of the inferior animals than in man. The black pigment exists also in considerable quantities in the interstices of the venous layer, and here the cells are said to be of a stellate form, and disposed in curved rows corresponding to the vorticose veins.

The *ciliary ligament* (*annulus albidus*) is a circular band of grayish-looking substance, situated on the inner surface of the sclerotic coat immediately behind its junction with the cornea. It serves as a common bond of union between the sclerotic and choroid coats, the retina, ciliary zone, and iris, and is traversed by the ciliary nerves, which here subdivide and anastomose freely with one another before entering the iris.

Fig. 251.

The anterior segment of a transverse section of the globe of the eye, seen from within. 1. The divided edge of the three tunics; sclerotic, choroid (the dark layer), and retina. 2. The pupil. 3. The iris, the surface presented to view in this section being the uvea. 4. The ciliary processes. 5. The anterior border of the retina.

The *ciliary body* (*corpus ciliare*) is best seen by making a transverse vertical section of the sclerotic, choroid, and retina, and looking in from behind through the vitreous humor. It is a dark, brownish-black, circular, flattened ring, formed by a folding in of the choroid coat upon the forepart of the vitreous body. Its folds, called the *ciliary processes*, are sixty or seventy in number, triangular in shape, and alternately long and short. It is connected by its periphery or greater circumference to the ciliary ligament, whilst its inner border is free and slightly overlaps the margin of the crystalline lens. The anterior surface corresponds to the posterior surface of the iris, from which it is separated by a narrow interval occupied by the aqueous humor and called the posterior chamber of the eye; the posterior rests upon the anterior surface of the vitreous body, which presents a corresponding number of triangular grooves into which the ciliary processes are received. The ciliary body does not differ in structure from the rest of the choroid coat, except in the greater abundance of the black pigment, and the absence of that vorticose arrangement of its vessels.

The IRIS (Figs. 251 and 252) is a circular membranous diaphragm, with an opening in the centre called the pupil. It is situated in the aqueous humor, between the cornea and crystalline lens, but much nearer to the latter, and divides the space into two unequal parts, called respectively the anterior and posterior chambers of the aqueous humor. It is attached by its outer border or greater cir-

cumference to the anterior edge of the ciliary ligament; its inner or lesser border floats in the aqueous humor, and corresponds to the aperture of the pupil. The anterior surface is variously colored in different individuals, and, when closely examined, will be found marked by numerous lines or ridges radiating from the pupillary margin toward the greater circumference; the posterior is covered by a thick layer of pigment, which gives it a bluish appearance, like that seen upon the inner surface of the choroid, and is called the *uvea*, from its resemblance in color to a grape.

Fig. 252.

The iris and the contiguous parts of the choroid coat seen in front, with the pupillary membrane from a seven months child. 1, 2. Long ciliary arteries. 3. Iris. 4. Pupillary membrane. 5. Vorticose veins of the choroid coat.

The *pupil* is not situated exactly in the centre of the iris, but a little to the inner or nasal side. It is of a circular form, communicates between the anterior and posterior chambers of the aqueous humor, and varies in size at different times, according as more or less light is to be admitted to the back part of the eye. Throughout the greater part of fœtal life, this opening is closed by a delicate membrane called the *pupillary membrane*, the vessels of which are continuous with those of the iris, and form loops meeting at the centre. About the seventh or eighth month, the membrane breaks at the centre, and the vascular loops gradually contract toward the future site of the pupillary margin. Not unfrequently shreds of this membrane may be seen in the eyes of new-born children, and occasionally the membrane remains entire until some days after birth.

Structure.—The iris is composed of a considerable quantity of pigment-cells, muscular fibres, bloodvessels, and nerves.

The *pigment cells*, as stated above, are most abundant upon the posterior surface of the membrane, and are very irregular in size and form. Those upon the anterior surface are less abundant and variously colored in different individuals.

The *muscular fibres* of the iris belong to the involuntary or unstriped variety, and are arranged into two sets, one radiating from the pupil toward the larger circumference of the membrane, and the other surrounding the pupil in the form of a circular band; the former dilate the pupil, and the latter contract it. In birds, the radiating fibres are said to be striped.

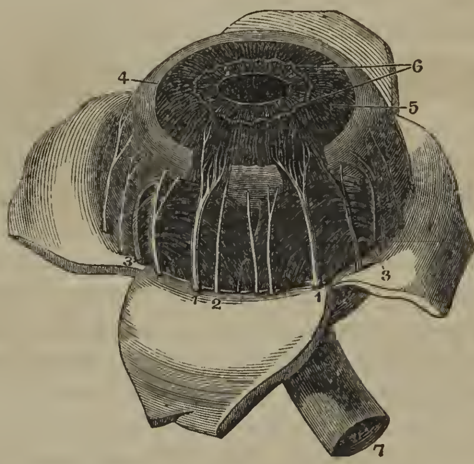
Arteries.—The long ciliary arteries, two in number, are derived from the ophthalmic; they perforate the sclerotic coat, and proceed horizontally forward between this membrane and the choroid to the ciliary ligament; before reaching this point, they each divide into a superior and an inferior branch, and from the subdivisions and anastomoses of these branches upon the larger circumference of the iris, a vascular zone is formed, from which numerous twigs proceed in the substance of the membrane in the direction

of the pupil. While lying between the sclerotic and choroid coats, the internal of these two arteries is situated a little below, and the external a little above the transverse axis of the eye. This circumstance should be borne in mind in the introduction of the needle in operating for cataract. The *short* or *anterior ciliary arteries* are numerous, and much smaller than the preceding; they perforate the sclerotic coat a short distance behind the cornea, and divide into branches which join the vascular zone upon the greater circumference of the iris.

The *veins* of the iris follow the same course as the arteries.

NERVES.—The ciliary nerves, fifteen or twenty in number, and remarkably large considering the small size of the iris, are derived from the ophthal-

Fig. 253.



Represents a dissection of the eye in which the sclerotic has been dissected off and turned down, in order to expose the nerves and some of the bloodvessels. 1, 1. Ciliary nerves entering the ciliary ligament and passing forward to the iris; the ligament is dissected away in two places to show their course. 2. Smaller ciliary nerve. 3. Vorticose veins, or veins of the exterior layer of the choroid. 4. Ciliary ligament. 5. Converging fibres of the greater circle of the iris. 6. Looped and knotted form of these fibres near the pupil; the knots or enlargements being regarded as ganglia by Meckel. Within the divergent or radiating fibres is seen the sphincter of the iris, the fibres of which are represented converging, but are now known to be concentric.

mic or lenticular ganglion and nasal branch of the fifth pair; they perforate the sclerotic at different points, proceed forward upon the surface of the choroid to the ciliary ligament, and within this ligament divide minutely, and then enter the substance of the iris.

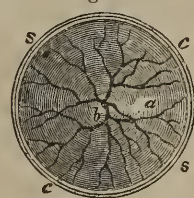
DISSECTION OF THE RETINA.—The retina cannot be perfectly dissected except under water. The sclerotic coat having been removed as before directed, the student should take two pairs of blunt forceps, one in each hand, and, having pinched up the choroid with one, in order to hold the membrane steady, he can then with the other tear it off in small pieces, taking great care not to get the retina in the grasp of the forceps or to let the eye roll about in a forcible manner.

The RETINA, the third tunic of the eye, consists essentially of the expansion of the optic nerve, to which, however, certain other structures are added. It is thin and almost transparent during life, exceedingly delicate, pulpy in its consistence, and situated between the choroid coat and the hyaloid membrane of the vitreous humor; and it extends from the entrance of the optic nerve to the ciliary ligament, behind which it seems to end in a thickened, well-defined border. The outer surface is connected very loosely to the choroid coat, and presents a rough, flocculent appearance. The inner surface rests upon the vitreous body, and is marked behind, directly in the antero-

Fig. 254.

The retina, after the removal of the choroid coat. 1. The retina. 2. Optic nerve. 3. Iris. 4. Vitreous body. 5. Termination of the retina at the posterior extremities of the ciliary processes of the vitreous body.

Fig. 255.



The yellow spots of Sœmmering, seen in the axis of the eye, with the entrance of the central artery of the retina about the eighth of an inch on the inner side of the axis. *a*. Yellow spot. *b*. Point of entrance of the optic nerve. *c*. Choroid coat. *s*. Sclerotic coat.

posterior axis of the organ, by a small yellow spot, once supposed to be a foramen; and hence called, after its discoverer, the foramen of Sœmmering.* About two lines to the inner or nasal side of this spot is a little papilla corresponding to the extremity of the optic nerve, and, passing between the two points, a slight ridge called the central fold of the retina. Emerging from the papilla will also be seen the central artery of the retina, which enters the eye in the substance of the optic nerve and ramifies upon the retina.

STRUCTURE.—The retina has been demonstrated by microscopists to consist of six separate layers, which, commencing with the most external, are: the membrane of Jacob, the granular layer, the ganglionary layer, the vesicular layer, the fibrous expansion of the optic nerve, and the vascular layer.

Jacob's membrane is composed of a single stratum of narrow and very minute elongated cells, arranged perpendicularly to the surface like the pile on velvet. Soon after death the cells separate from each other, become

* The yellow spot exists only in man and those animals the visual axis of whose eyes are parallel with each other.

broken up, and give to the exterior of the retina the rough flocculent appearance before mentioned.

The *granular layer*, the next in order, possesses considerable thickness, and consists of numerous nucleolated nuclei, resembling somewhat those found in the convolutions of the brain,* imbedded in a granular matrix.

The *ganglionary layer*, situated beneath the preceding, is exceedingly thin and delicate. It consists of caudate ganglionary globules of various sizes, having an exact similarity to those of nerve ganglia in different parts of the body.

The *vesicular layer*, the fourth in the series, consists of large, transparent, globular cells, of which the most external are granular and nucleated.

The *fibrous layer* is composed, according to the observations of Hassal, of gray gelatinous nerve fibres, held together by a small quantity of nucleated fibrous tissue. It is the proper expansion of the optic nerve, the tubular fibres of which are here converted into branched unnucleated fibres, similar in all respects to the gray nerve fibres found in nearly all parts of the nervous system.

The *vascular layer* is formed by the ramifications of the central artery of the retina, held together by a small quantity of connecting areolar tissue. It supports the preceding layer, and is in immediate contact with the vitreous body.

THE HUMORS OF THE EYE.

The humors of the eye are transparent, refracting media of different consistences, through which the light passes from the cornea on its way to the retina. They serve also to give fulness and rotundity to the organ. They are the *vitreous body*, *crystalline lens*, and *aqueous humor*.

The VITREOUS BODY is a clear, transparent, gelatinous mass, of an irregularly spheroidal form, occupying the posterior two-thirds or three-fourths of the interior of the eye. Although apparently a homogeneous structure, it consists of a delicate investment called the hyaloid membrane, and an inclosed fluid which is the vitreous humor.

The *hyaloid membrane* is an exceedingly delicate, transparent structure, which not only forms the exterior covering of the vitreous body, but gives off numerous membranous processes from its inner surface, by which the inclosed space is divided into a great many small compartments (Fig. 248). The number of these compartments is over 150; they all communicate with each other, and are mostly of an angular form. Those surrounding the antero-posterior axis of the organ are said to be wedge-shaped, their sharp edges presenting toward each other, and inclosing a minute circular canal.

* Hassal.

The *vitreous humor* occupies the compartments of the hyaloid membrane; it is a clear, limpid fluid, about the consistence of slightly viscid mucilage, and composed of pure water holding in solution about two per cent. of animal and saline matters.

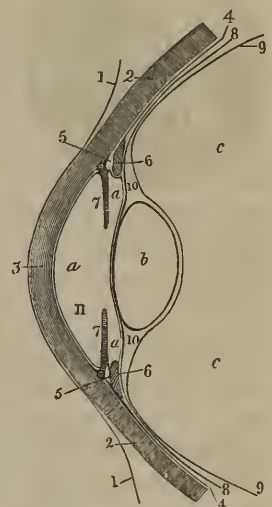
The circumference of the vitreous body is in contact with the entire internal surface of the retina, and presents in front a circular excavation for the reception of the greater convexity of the crystalline lens. The surface surrounding the lens is in close contact with the ciliary processes, from which it receives a brownish discoloration, and is marked by a like number of radiated folds, forming what is called the *ciliary zone*, or *zone of Zinn*. These folds correspond in number to the ciliary processes, between which they are accurately fitted, but are rather larger and much less prominent.

Immediately around the margin of the crystalline lens the hyaloid membrane separates into two layers, one of which passes in front of the lens and the other behind it. The narrow triangular passage thus left around the circumference of this body, is called the *canal of Petit* (Fig. 248, 16; and Fig. 256, 10).

No vessels or nerves can be traced into the vitreous body of an adult, but, in the fœtus, a small arterial twig proceeds from the central artery of the retina through the middle of the organ from behind forward, to reach the back part of the crystalline lens, upon which it is distributed.

The CRYSTALLINE LENS is a transparent solid body, having a double convex form. It is situated directly in the axis of the eye, a short distance behind the pupil, and imbedded in the cup-shaped depression upon the anterior surface of the vitreous body. The *anterior surface* is slightly convex, and covered by the hyaloid membrane; it forms the posterior wall of the posterior chamber of the aqueous humor, by which it is separated from the iris, and, when the pupil is widely dilated, it is ex-

Fig. 256.



Plan of the structures in the fore part of the eye, seen in section. 1. Conjunctiva. 2. Sclerotic. 3. Cornea. 4. Choroid. 5. Ciliary ligament. 6. Ciliary processes. 7. Iris. 8. Retina. 9. Hyaloid membrane. 10. Canal of Petit (made too large). 11. Membrane of the aqueous humor (too thick). *a*. Aqueous humor, anterior chamber, and (*a*) posterior chamber. *b*. Crystalline lens. *c*. Vitreous humor.

posed to view throughout almost its entire extent. The *posterior surface* is much more convex than the anterior, and accurately fills the concavity upon the forepart of the vitreous body. The circumference is inclosed by the separation of the hyaloid membrane, surrounded by the canal of Petit, and very slightly overlapped by the points of the ciliary processes.

The crystalline lens consists of an investing membrane, called the capsule, and an inclosed substance, which is the lens proper, sometimes called the body of the lens.

The *capsule* of the lens is a firm, transparent membrane, much thicker in front than behind, and composed of an elastic horny tissue precisely similar to the posterior elastic lamina of the cornea.

The *proper substance* of the lens is separated from the interior of the capsule by a minute quantity of watery fluid. In the fresh state, it appears to be a firm and jelly-like transparent mass, semifluid upon its exterior, but increasing in consistence toward the centre, where it forms a small round nucleus of horny hardness. When hardened in alcohol, it readily separates into three wedge-shaped segments, each one of which may be resolved into a number of superimposed lamellæ, and these lamellæ are found, under the microscope, to consist of well-marked fibres of a peculiar kind, having a most curious and beautiful arrangement. No vessels or nerves exist in the crystalline lens, but, in the fœtus, a small arterial twig may be traced from the middle artery of the retina through the centre of the vitreous body to the back part of the capsule.

Fig. 257.

Lens, hardened in spirit and partially divided along the three interior planes, as well as into lamellæ.—Magnified $3\frac{1}{2}$ diameters. (After Arnold.)

The crystalline lens differs in several important particulars at different periods of life. Thus, in the fœtus, it is nearly spherical, of a pinkish color, and almost fluid consistence; in the adult, it is perfectly transparent, of moderate firmness, and much more convex upon its posterior than its anterior surface; in old age, it is often of a yellowish tinge, tough, and sometimes almost horny in its consistence, and flattened upon both surfaces.

The AQUEOUS HUMOR is a thin, transparent fluid, occupying the interval between the cornea in front and the crystalline lens and ciliary processes behind. This space is divided by the iris into two

unequal parts, called the *anterior* and *posterior chambers* of the eye. The former is much the larger, and communicates with the latter through the pupil. The aqueous humor does not usually exceed five or six grains in weight, and consists of pure water, holding in solution about two per cent. of chloride of sodium and a minute quantity of albumen.

The aqueous humor is supposed, by some anatomists, to be derived from the vitreous body, and by others, to be secreted from the membrane forming the posterior lamina of the cornea, which is hence sometimes called the capsule of the aqueous humor.

VESSELS AND NERVES OF THE ORBIT.

The structures within the orbit are supplied almost entirely by the ophthalmic artery, in addition to which, however, a few small twigs are received from the fascial, temporal, and internal maxillary.

The *ophthalmic artery*, a vessel about the size of an ordinary pocket probe, arises from the internal carotid upon the inner side of the anterior clinoid process of the sphenoid bone, passes forward through the optic foramen beneath the optic nerve, but soon leaves this nerve to its inner side, and then turns obliquely across its upper surface to reach the nasal side of the orbit, in which situation it proceeds in a tortuous manner toward the inner angle of the eye, where it divides into a nasal and a frontal branch. In its course it gives off the following branches:—

1. The *lachrymal*, one of the largest of the branches of the ophthalmic, arises from the main trunk close to the optic foramen, passes forward between the external straight muscle and outer ball of the orbit, and is distributed to the lachrymal gland and upper eyelid.

2. The *central artery of the retina*, very small, arises near the preceding, enters the substance of the optic nerve, and in this relation reaches the interior of the ball of the eye, where it divides minutely to supply the retina; in the fœtus, it sends a small twig through the vitreous body to the back part of the crystalline lens.

3. The *anterior*, or *short ciliary arteries*, ten or twenty in number, and very small, arise from various parts of the ophthalmic, proceed forward around the optic nerve, and perforate the sclerotic coat of the eye a short distance behind the cornea, to be distributed principally to the iris.

4. The two *long ciliary arteries* arise from the outer side of the ophthalmic near the back part of the eyeball, perforate the sclerotic coat on each side of the optic nerve, and proceed forward upon the surface of the choroid coat to the iris, the internal situated a little above, and the external a little below the transverse axis of the eye.

5. The *muscular branches*, from three to five in number, supply the straight and oblique muscles of the eye and the elevator of the upper eyelid.

6. The *ethmoidal artery* arises near the posterior internal orbital foramen, through which it reaches the ethmoidal cells, and is distributed to the lining mucous membrane; it also sends a few twigs through the cribriform plate of the ethmoid bone to the anterior extremity of the cerebral falx.

7. The *superior and inferior palpebral branches* arise near the preceding, and are distributed to the eyelids, lachrymal caruncle, conjunctiva, and lachrymal sac.

8. The *supra-orbital*, one of the largest of the branches of the ophthalmic, originates far back, proceeds forward between the elevator of the upper eyelid and roof of the orbit, emerges at the supra-orbital notch, and is distributed to the orbicular and occipito-frontal muscles.

9. The *nasal branch*, one of the terminal divisions of the ophthalmic, leaves the orbit above the ocular tendon, and descends upon the side of the nose, inosculating with the nasal branches of the fascial.

10. The *frontal branch* leaves the orbit at its superior internal angle, and is distributed to the skin of the upper eyelid and forehead, and subjacent muscles.

The VEINS from the eyelids and inner part of the orbit terminate in the veins of the forehead and face; those from the eyeball and its muscles correspond to the arterial branches, and unite to form a single main trunk, the *ophthalmic vein*, which proceeds backward below the external straight muscle, traverses the sphenoidal fissure, and opens into the cavernous sinus.

NERVES.—The visual organs receive the entire distribution of the second (optic), third, and fourth nerves, and branches from the fifth, facial, and sympathetic.

The OPTIC NERVE enters the orbit through the optic foramen, accompanied by the ophthalmic artery, proceeds forward and a little inward, and, having reached the eyeball, perforates the sclerotic and choroid coats about a line and a half to the inner side of the antero-posterior axis of the organ. Upon leaving the cranial cavity it is covered by a strong fibrous sheath, which is continuous on the one hand with the dura mater, and on the other with the sclerotic coat of the eye. In its course through the orbit it is surrounded by the muscles of the eye, a large quantity of adipose tissue, the ophthalmic artery and its branches, and the nerves next to be mentioned.

The OPHTHALMIC NERVE, the first branch of the fifth pair, arises from the upper part of the Gasserian ganglion, enters the orbit through the sphenoidal fissure, and divides into three branches, namely, the frontal, lachrymal, and nasal.

1. The *frontal* branch proceeds forward between the elevator muscle of the upper lid and the roof of the orbit, and, emerging at the supra-orbital notch, is distributed principally to the skin of the forehead. In its course within the orbit it sends off the supra-trochlear branch to the upper part of the superior oblique or trochlear muscle, and a small filament to join the infra-trochlear nerve.

2. The *lachrymal* branch passes along the superior and external part of the orbit, and supplies the lachrymal gland, conjunctiva, and upper eyelid.

3. The *nasal* branch crosses obliquely below the superior straight muscle to gain the superior inner part of the orbit, and enters the anterior internal orbital foramen. Before reaching this point, it sends filaments to the lenticular ganglion, several considerable sized twigs, called the *long ciliary nerves*, to the ball of the eye, and a single branch, named the *infra-trochlear nerve*, to the parts about the inner canthus of the eye.

The FOURTH NERVE (*trochlearis* or *patheticus*) enters the orbit through the sphenoidal fissure, passes obliquely across the commencement of the elevator muscle of the eyelid in close connection with the lachrymal branch of the ophthalmic nerve, and is distributed exclusively to the superior oblique or trochlear muscle of the eye.

Fig. 258.

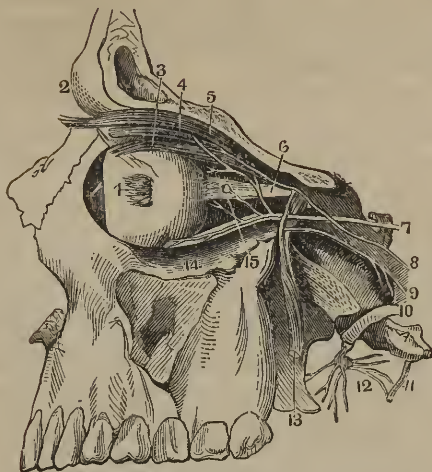


Fig. 258 shows the nerves of the orbit, with the ophthalmic and otic ganglia. 1. Ball of the eye. 2. Superciliary ridge of the left side. 3. Superior straight muscle. 4. Superior oblique muscle. 5. Elevator of the upper eyelid. 6. Optic nerve. 7. Third nerve. 8. Fourth nerve. 9. Sixth nerve. 10. Trunk of the inferior maxillary nerve. 11. Middle artery of the dura mater entering the spinal foramen of the sphenoid bone. 12. The otic ganglion. 13. External straight muscle, divided and turned down. 14. Floor of the orbit. 15. Ophthalmic or lenticular ganglion.

The THIRD, or COMMON MOTOR NERVE OF THE EYE, passes from its origin through the external wall of the cavernous sinus, lying to the outer side of the internal carotid artery and upon the inner side of the fourth and ophthalmic nerves, receives a filament from the sympathetic and one from the ophthalmic nerves, and there divides into a superior and an inferior branch, which enter the orbit through the sphenoidal fissure. The *superior* division proceeds forward and upward beneath the superior straight muscle, and divides into a great number of branches, most of which are distributed to this muscle, and the others to the elevator of the upper lid and internal straight muscle. The *inferior* division, the larger of the two, passes forward between the optic and the sixth nerves, and divides into three branches, which are distributed respectively to the internal and external straight and inferior oblique muscles.

The SIXTH, or EXTERNAL MOTOR NERVE OF THE EYE (*abducens*), after traversing the external wall of the cavernous sinus, where it receives filaments from the carotid plexus of the sympathetic, enters the orbit through the lower part of the sphenoidal fissure, and, crossing obliquely beneath the ophthalmic nerve, enters the external straight muscle, to which it is exclusively distributed.

The *ciliary* or *lenticular ganglion*, to which reference has been so often made in the preceding pages, is a very small, irregularly quadrilateral, grayish-looking body, situated upon the outer surface of the optic nerve, two or three lines in front of the optic foramen. It receives from behind a filament from the nasal branch of the ophthalmic, to which it in all probability belongs,

one from the third nerve, and an exceedingly small one from the sympathetic, and gives off from its anterior angles two fasciculi, containing altogether about twenty nerves, called the *ciliary nerves,* which proceed forward around the optic nerve to the ball of the eye, perforate the sclerotic coat, and are distributed principally to the iris.

THE EAR.

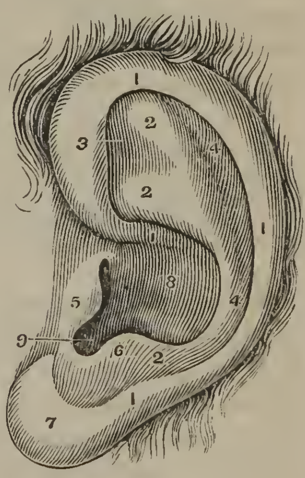
THE ear is divided into three parts, named, from their relative position, the external, middle, and internal.

THE EXTERNAL EAR.

The external ear comprises the pinna or auricle projecting from the side of the head, and the canal or meatus leading to the tympanum.

The auricle (*pinna*), to which part the term *ear* is in common usage restricted, is an expanded elastic lamina intended to catch the undulations of sound and direct them into the meatus. Its size, shape, and situation are familiar to every one, and do not require any special description. Its different parts have received certain technical names, with some of which it is necessary to become acquainted, on account of their frequent occurrence in referring to this organ. Thus, the large funnel-shaped excavation situated a little below the middle and leading directly to the meatus, is called the *concha* (Fig. 259, 8); the triangular teat-like process (5) in front of the concha is the *tragus;* below the concha, and separated from the tragus by a deep notch, is another but smaller eminence (6) called the *antitragus;* the curved projecting edge of the auricle (1, 1) is termed the *helix;* the rounded ridge (2, 2) in front of the helix is the *antihelix;* the

Fig. 259.



The pinna, or auricle of the external ear.

superficial excavation (3) above the antihelix is the *scaphoid* or *navicular fossa;* the soft appendage (7) forming the point of the auricle, and to which the ear-ring is attached, is called the *lobule* (*lobus*).

The inner surface of the pinna looks toward the side of the head, and presents numerous irregularities, the reverse of those upon the opposite side.

Structure.—The pinna consists principally of a plate of fibro-cartilage, upon which the shape and elasticity of the part depends, and to this is superadded a certain amount of fibrous and muscular tissue. The lobule differs from the rest in being composed entirely of areolar and adipose tissue.

Ligaments.—The pinna is attached to the side of the head by two ligaments, one *anterior*, extending from the helix to the root of the zygoma, and a *posterior*, from the back of the concha to the mastoid process.

Muscles.—The muscles of the pinna are extrinsic and intrinsic. The *extrinsic* muscles (Fig. 203) have been already described in connection with the temporal aponeurosis upon which they rest; they are the posterior auricular (*retrahens aurem*), superior auricular (*attollens* or *elevator*), and interior auricular (*attrahens*). The *intrinsic* muscles, four or five in number, consist of thin pale fibres passing from one part of the fibro-cartilage to another, but are so imperfectly developed in the human subject that it is barely necessary to mention their existence.

Bloodvessels and Nerves.—The pinna is supplied with arterial blood by branches from the posterior auricular and temporal arteries. The nerves, few and very small, are filaments from the cervical plexus and facial nerve.

The EXTERNAL AUDITORY CANAL, OR MEATUS, is the passage from the concha to the middle ear or tympanum. It is about an inch in length, slightly curved in its direction, the convexity presenting upward, and closed at its internal extremity by the membrane of the tympanum or drum of the ear.

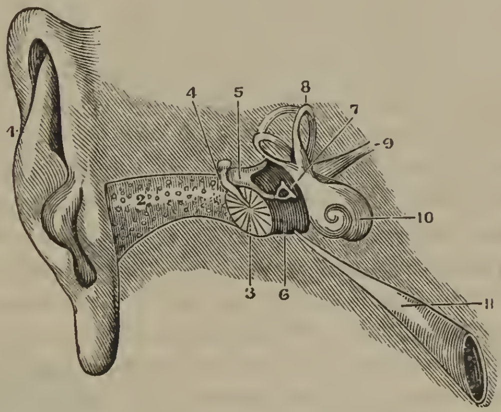
The first half of the canal consists of a fibro-cartilaginous tube continuous with the concha; the internal half is formed by the temporal bone. It is lined by a prolongation of skin which becomes

thinner toward the drum, and upon the external surface of this membrane consists only of the epidermic layer. The skin is covered with numerous fine hairs intended to prevent the entrance of dust, and contains a number of little oval-shaped glands for the secretion of the cerumen or ear-wax.

THE MIDDLE EAR, OR TYMPANUM.

The tympanum is a small irregular cavity situated in the substance of the petrous portion of the temporal bone, between the internal ear and the termination of the external meatus. It communicates

Fig. 260.



The internal and external ear. 1. Ear. 2. External auditory meatus, with its ceruminous glands. 3. Membrane of the tympanum. 4. Malleus. 5. Incus. 6. Cavity of the tympanum. 7. Stapes. 8. Semicircular canals. 9. Auditory nerves entering the cochlea. 10. Cochlea. 11. Eustachian tube.

with the pharynx through the Eustachian tube, and with the cells in the mastoid portion of the temporal, and contains the small bones of the ear and their special muscles.

Dissection.—The tympanum should be studied in the dried bone as well as in its recent state. It is best exposed by carefully breaking through the petrous portion of the temporal bone immediately above the cavity, and removing the fragments with a pair of forceps, or by sawing across the base of the bone, near the bottom of the external meatus, and cutting through the drum. Another good method is to macerate a fresh temporal bone in dilute muriatic acid, so as to remove its earthy part, and then with a scalpel cut away the upper wall of the cavity.

The cavity of the tympanum is irregularly oblong, flattened

from within outward; its antero-posterior and vertical diameters measuring nearly half an inch, and its transverse only about two lines. Its *superior wall* is concave, and formed by the union of the petrous and squamous portions of the temporal bone internal to the posterior root of the zygoma. The *inferior* wall is a narrow groove or trench, which crosses the base of the bony plate that separates the condyloid from the jugular fossa in an antero-posterior direction. The *external* wall is formed by the membrane of the tympanum. The internal wall is uneven, and perforated above by a small *oval opening* (*fenestra ovalis*) which communicates with the vestibule, but is closed in the fresh state by the base of the stapes; above this opening is a bony projection corresponding to the aqueduct of Fallopius, and below it a rounded elevation called the *promontory*, corresponding to the first turn of the cochlea, and marked by grooves leading downward to a minute canal. The grooves lodge the tympanic plexus formed by the anastomosis of filaments from the glosso-pharyngeal, Vidian, Jacobson's, and sympathetic nerves; the canal descends inward to open upon the base of the temporal bone, between the jugular fossa and carotid canal, and gives passage to Jacobson's nerve. Behind the oval opening and promontory is a small eminence called the *pyramid*, the summit of which is perforated by a minute foramen, said to be for the passage of the delicate tendon of the stapedius muscle. Below and behind the base of the promontory is a small *round opening* (*fenestra rotunda*) communicating with the cochlea, but closed in the recent state by a delicate membrane, called the secondary membrane of the tympanum.

The *posterior wall* of the tympanum is perforated by several small openings and one large one, which communicate with the cells of the mastoid process.

The *anterior extremity* of the tympanum is contracted and narrow, and leads to two small openings separated by a thin lamella of bone; the superior of the two lodges the tensor muscle of the tympanum; the inferior and larger is the termination of the bony part of the Eustachian tube.

The tympanum is lined throughout by a delicate mucous membrane, continuous through the Eustachian tube with the lining membrane of the pharynx, and prolonged through the openings in the back of the cavity into the cells of the mastoid process.

The MEMBRANE OF THE TYMPANUM (*membrana tympani*) is a circular semitransparent septum, directed obliquely downward and inward across the internal extremity of the external auditory canal,

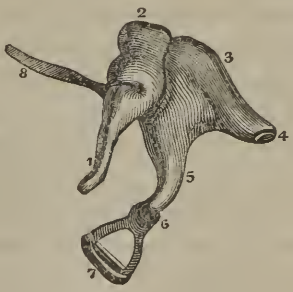
the circumference of which is here grooved for its insertion. The external surface is slightly concave, and covered by the cuticular prolongation of the skin lining the external meatus; the internal surface is correspondingly convex, covered by the mucous membrane of the tympanum, and gives attachment to the handle of the malleus, one of the ossicles of the ear. Between the cuticular and mucous layers is the proper substance of the membrane, which consists of fine, closely arranged fibres, directed for the most part from the centre toward the circumference. The nature of these fibres is not positively ascertained. The use of the membrane of the tympanum is to receive the vibrations of sound, which are thence transmitted across the tympanum by the chain of small bones to the oval opening upon the inner wall, where they impinge upon the internal ear containing the expansion of the auditory nerve.

The EUSTACHIAN TUBE is a trumpet-shaped canal, nearly two inches long, communicating between the throat and the tympanum. Its guttural orifice is circular, and sufficiently large to admit the end of the little finger; it is situated upon the upper part of the lateral wall of the pharynx a little above and behind the posterior extremity of the inferior turbinate bone, and may be reached by a probe or catheter slightly bent near the point and introduced along the floor of the nose. From this point, the tube leads upward, backward,

Fig. 261.

Ossicles of the ear of the natural size. 1. Malleus. 2. Incus. 3. Orbicularis. 4. Stapes. (From J. Bell.)

Fig. 262.



Bones of the tympanum in their natural juxtaposition, magnified three diameters. 1. Handle of the malleus. 2. Head of the malleus. 3. Body of the incus. 4. Its short process. 5. Its long process. 6. Orbicular bone. 7. Stapes. 8. Long process of the malleus.

and outward; and, having narrowed to the size of a common probe, terminates in the anterior extremity of the cavity of the tympanum.

The lower two-thirds of the Eustachian tube is composed of fibro-cartilage; the superior third is the upper of the two small bony canals found in the receding angle formed in front by the union of the squamous and petrous portions of the temporal bone. The tube is lined by a mucous membrane continuous with that of the pharynx and tympanum.

The SMALL BONES or OSSICLES OF THE EAR, three in number, form a connected chain across the upper part of the cavity of the tympanum, reaching from the convex surface of the membrane of the tympanum to the oval opening communicating with the vestibule. Their office is to conduct the sonorous vibrations from the membrane of the tympanum to the fluid contained within the internal ear. Their size, shape, and situation will be better understood by reference to Figs. 260, 261, and 262 than from any description, however accurate.

The MALLEUS, so called from its hammer-like shape, is the middle in point of size, and as regards its position the most external of the bones of the ear. It consists of a body having a rounded head and two long processes, of which one is horizontal and the other vertical, the latter the larger of the two, and commonly called the handle (*manubrium*); another little offset from the base of the handle is distinguished as the short process.

The *handle* of the malleus is received between the internal and middle layers of the membrane of the tympanum, to the latter of which it is closely attached. The *horizontal process* (long process, *processus gracilis*), long and slender, extends obliquely downward and forward to the Gasserian fissure, where it is attached by ligamentous fibres. The *short process* is in contact with the middle layer of the membrane of the tympanum near the upper edge. The *head* projects above the membrane of the tympanum, and articulates by its inner surface with the incus.

The INCUS, the largest of the bones of the ear, consists of an irregularly quadrangular body and two processes. The body is very uneven, and marked upon its upper surface by a slight concavity tipped with cartilage for articulation with the side of the head of the malleus. One of the processes is short and thick, directed horizontally backward, and connected to the posterior wall of the tympanum by a few ligamentous fibres; the other is long and slender, bent at its extremity, and terminated by a rounded tubercle for articulation with the stapes. The tubercle by which the long process joins the stapes is often described as a separate piece, called the *lenticular* or *orbicular bone* (*os orbiculare*).

The STAPES, the most internal and smallest of the three bones, is shaped, as its name indicates, like a stirrup. Its head is directed outward, and presents a slight concavity for articulation with the end of the long process of the incus. The base is applied over the oval opening (*fenestra ovalis*), to the margins of which it is connected by ligamentous fibres.

Ligaments and Muscles of the Tympanum.—The opposed surfaces of the bones of the tympanum are covered by thin layers of

cartilage and delicate synovial membranes, and held together by surrounding ligamentous fibres. They admit, therefore, of a certain degree of motion, the object of which doubtless is to break the force of the sonorous vibrations, and thus protect the internal ear from sudden and violent impulses. The use of the bones is therefore analogous to that of the iris, which regulates the admission of light to the retina, a fact that is farther proved by the existence here of at least one muscle, by the contraction and relaxation of which the chain of bones is relaxed or made rigid, as occasion may require. Thus, when the sonorous vibrations are slight, the muscle contracts, and renders the chain of bones almost as rigid and unyielding as though composed of a single piece, so that nothing may be lost; and on the other hand, when the vibrations are violent and sudden, the muscle relaxes, and the chain being thus allowed to bend at the two articulations, the force of the impulse is in a great measure lost before it reaches the internal ear.

Owing to the minuteness and delicacy of the muscles of the tympanum, different observers have arrived at very different conclusions in regard to their number. Thus Sœmmering describes four and Mr. Todd nine, while Cruveilhier doubts the presence of more than one. The four mentioned by Sœmmering are the tensor of the tympanum, the greater and lesser laxator of the tympanum, and the stapedius. Of these, the *tensor of the tympanum* (*tensor tympani*) is the only one about the existence of which there is no dispute. It consists of a small, tapering, fleshy belly, which arises from the cartilaginous part of the Eustachian tube near where it joins the bone, and from the adjacent margins of the bony canal lying immediately above and parallel with the bony part of the tube; it passes horizontally backward through that canal to the forepart of the tympanum, and there ends in a delicate tendon which turns over a pulley-like surface upon the cochleaform process, and passes outward to be inserted into the forepart of the handle of the malleus near its root.

Use.—To draw the handle of the malleus inward and its head outward; the incus, from its firm connection with the head of the malleus, follows that bone; and, as it swings upon its short horizontal process, its vertical process is carried inward, and therefore presses the stapes against the oval opening,* or, in other words, renders the chain of bones stiff and unyielding.

In regard to the other muscles said to be connected with the

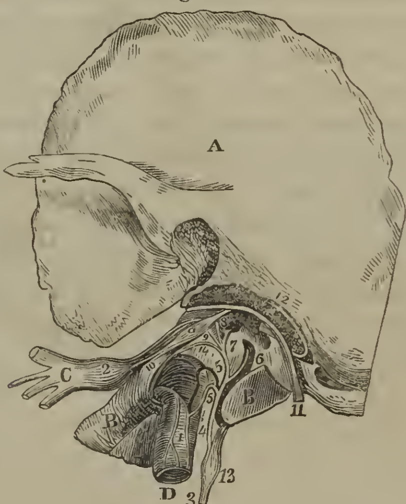
* Cruveilhier.

ossicles of the ear, the author is inclined to doubt their existence, simply for the reason that there seems to be no use for them, the tensor of the tympanum being able to accomplish all that is necessary, which consists simply in regulating the tension of the bony chain to suit the force of the vibrations of the membrane of the tympanum.

VESSELS AND NERVES.—The *arteries* of the tympanum are minute branches of the internal maxillary, internal carotid, and posterior auricular. The *veins* follow the course of the arteries, and terminate in the middle meningeal and pharyngeal veins.

The *nerves* of the tympanum are derived from the tympanic plexus, which is situated upon the promontory of the tympanum, and formed by commu-

Fig. 263.



A drawing of the tympanic nerve from Breschet's work on the ear. A. Squamous part of temporal bone. B. Petrous portion of same. C. Lower maxillary nerve. D. Internal carotid artery. *a*. Tensor tympani muscle. 1. Carotid plexus. 2 Otic ganglion. 3. Glosso-pharyngeal nerve. 4. Tympanic nerve. 5. Branches to carotid plexus. 6. Branch to fenestra rotunda. 7. Branch to fenestra ovalis. 8. Branch to join the large superficial petrosal nerve. 9. Small superficial petrosal nerve. 10. Nerve to tensor tympani muscle. 11. Facial nerve. 12. Chorda tympani. 13. Petrous ganglion of the glosso-pharyngeal. 14. Branch to the membrane liniug the Eustachian tube.

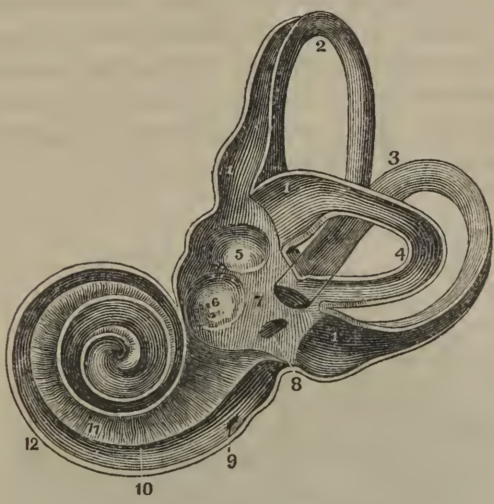
nications between Jacobson's nerve, a filament from the carotid plexus, a branch which joins the great superficial petrosal nerve, and lastly the small superficial petrosal nerve from the otic ganglion. The arrangement of these nerves may be seen in the accompanying figure (263).

THE INTERNAL EAR, OR LABYRINTH.

The internal ear, the sentient division of the organ of hearing, is situated in the substance of the petrous bone, between the tympanum and the internal auditory meatus. It consists of a tortuous passage, called the bony labyrinth, in which is contained the expansion of the auditory nerve, supported by a fibro-vascular membrane, called the membranous labyrinth.

The OSSEOUS LABYRINTH is divided into three parts, named respectively the vestibule, semicircular canals, and cochlea.

Fig. 264.



The osseous labyrinth, largely magnified and divided longitudinally. 7. The vestibule. 8. Aqueduct of the vestibule. 5. Semielliptic fossa. 6. Hemispheric fossa. 2, 3, 4. Semicircular canals. 2. Superior semicircular canal. 3. Posterior canal. 4. Inferior canal. 1, 1, 1. Ampullated extremity of each canal. 12. Cochlea. 9. Aqueduct of the cochlea. 11. Osseous zone of the spiral lamina, above which is the scala vestibuli communicating with the vestibule. 10. Scala tympani, below the spiral lamina.

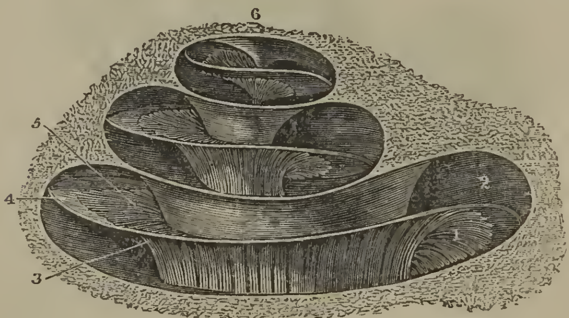
The *vestibule*, the dilated central chamber or body of the labyrinth, is about the size of a grain of wheat, compressed laterally, and placed midway and vertically between the semicircular canals behind and the cochlea in front. Its outer wall forms the internal wall of the tympanum, and presents the oval opening (*fenestra ovalis*), to which the base of the stapes is attached. The inner or posterior wall is perforated by numerous small foramina, for the entrance of the branches of the auditory nerve. Upon the same part is the orifice of a small canal called the *aqueduct of the vestibule*, which

terminates upon the posterior surface of the petrous bone, and transmits a venous twig. The anterior extremity leads to the mouth or entrance of the cochlea; the posterior is perforated by five round openings communicating with the semicircular canals.

The *semicircular canals* are three bony tubes, of different sizes, bent as represented in the preceding figure, and communicating, as before mentioned, with the upper back part of the vestibule. The superior one is nearly vertical, and forms a small elevation on the upper surface of the petrous portion of the temporal bone. Near the mouth of each one will be observed a slight dilatation called the *ampulla*.

The COCHLEA is a bony canal, about an inch and a half long and little more than a line in diameter, coiled upon itself two or three times, so as to form a blunt cone, whose base presents toward the internal auditory meatus. Its external surface is marked by a spiral groove corresponding to the septum, which separates the coils of the canal, and gives to it the appearance of a snail's shell, from which circumstance its name is derived.

Fig. 265.



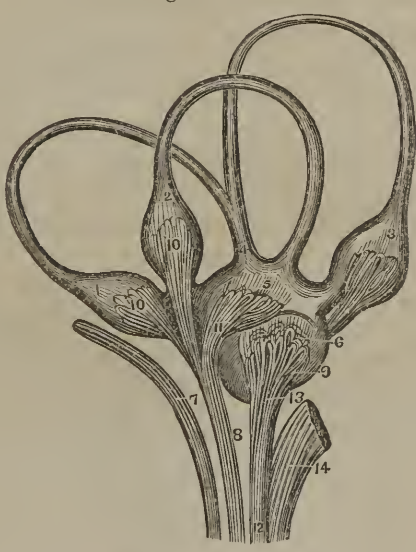
Magnified view of the cochlea of a new-born infant, opened on the side towards the apex of the petrous portion of the temporal bone. 1. Scala tympani. 2. Scala vestibuli. 3. Spiral lamina. 4. Zone of Valsalva. 5. Osseous zone. 6. Cupola.

The central pillar, called the *modiolus*, around which the cochlea is wound, is soft and spongy, and traversed by numerous canals which transmit branches of the auditory nerve. Its outer surface is marked by a spiral ridge or crest of compact bony tissue called the *spiral lamina*, which projects into the canal and divides it partially into two half canals, called the *scalæ*. In the recent state, this division is completed by a membranous septum, called the *zone of Val-*

salva, nearly as far as the blind extremity or *cupola* of the canal, where the two communicate with each other. One of the scalæ (*scala tympani*) communicates with the tympanum by the round opening, which, however, is closed in the recent state by a fibrous membrane called the secondary membrane of the tympanum. Near this opening is the orifice of a minute canal named the *aqueduct of the cochlea*, which terminates at the jugular fossa and transmits a small vein. The *scala vestibuli*, the superior of the two, communicates with the vestibule by a large orifice.

Lining Membrane of the Labyrinth.—The three divisions of the labyrinth are lined by a continuous fibro-serous membrane, whose outer surface is closely attached to the walls of the cavity. Its entire surface is smooth, and covered by a scaly epithelium, and secretes a thin serous fluid called the *liquor cotunnii*, or the *peri-*

Fig. 266.



The membranous labyrinth with its vestibule, semicircular canals, and nerves. 1. The superior semicircular canal. 2. The external semicircular canal. 3. The inferior semicircular canal. 4. Union of the superior and inferior canals. 5. The utricle. 6. The saccula. 7. The facial nerve. 8. The anterior fascicle of the auditory nerve. 9. The nerve of the saccula. 10, 10. The nervous fascicles of the superior and external ampullæ. 11. The nerve of the utricle. 12. Posterior fascicle of the auditory nerve, furnishing 13, the filaments to the saccule, and 14, filaments to the cochlea.

lymph, which occupies the space between the bony and the membranous labyrinth. It is by the continuation of this membrane

across the oval and round openings that the communication between the tympanum and labyrinth is entirely closed.

The MEMBRANOUS LABYRINTH is a delicate membranous sac contained within the bony labyrinth, which it exactly resembles in form, but is smaller, and separated from the surrounding walls by the perilymph. The vestibular portion of the sac is divided into two unequal parts, of which the larger is named the utricle and the smaller the saccule. The *utricle*, or common sinus, is situated in the upper back part of the vestibule; it communicates by five large orifices with the membranous semicircular canals, and receives upon its outer wall the branches of the auditory nerve that traverse the foramina in the bone in this situation. The *saccule* has a more globular form, is situated in the lower and anterior part of the vestibule, near the mouth of the vestibular scala, and, although in contact with the utricle, is said to have no communication with it.

The semicircular portion of the membranous labyrinth conforms precisely to the bony semicircular canals, from which it is separated by a small quantity of perilymph. It communicates by five orifices with the cavity of the utricle, and opposite each ampulla receives branches of the auditory nerve.

The vestibular and semicircular divisions of the membranous labyrinth are filled with a thin, limpid fluid, called the *endolymph*, floating in which, upon each side of the delicate septum that separates the utricle and saccule, is a little rounded calcareous body called the *otolith*.

STRUCTURE.—The structure of the walls of the common sinus, saccule, and membranous semicircular canals, presents many points of resemblance. The membrane of which they are formed is generally thin and semitransparent, but it is thicker and more opaque where nerves and vessels enter. On the outer surface is a layer of minutely ramified bloodvessels, and loose areolar tissue which sometimes contains irregular deposits of pigment cells. Next to this vascular network branches of the auditory nerve are distributed in the form of a distinct layer, within which is fine areolar tissue, with, according to Huschke, a film of closely set nucleated epithelium cells. It is doubtful how far the nervous layer extends in the semicircular canals beyond the ampullæ.*

The membranous structure of the cochlea is not arranged in the form of a sac, as in the vestibule and semicircular canals, but consists of two layers resting on the opposite surfaces of the spiral lamina, and continuous with each other at the cupola. The cavities of the two scalæ are otherwise entirely filled with perilymph.

* Sharpey and Quain.

Vessels and Nerves of the Labyrinth.—The special *artery* of the internal ear is a small branch of the basilar called the *internal auditory*, which enters the internal auditory meatus in company with the auditory and facial nerves, and, having reached the bottom of the canal, divides into vestibular and cochlear branches. Its ultimate ramifications are spent upon the membranous labyrinth.

The AUDITORY NERVE, the only nerve distributed to the internal ear, enters the internal auditory meatus in company with the internal auditory artery and facial nerve, and, at the bottom of that canal, the nervous filaments become freed of their common fibrous sheath, and pass through the foramina in the cribriform plate of bone that bounds the osseous labyrinth in this situation. Having entered the bony labyrinth, the filaments become collected into six bundles, which are distributed respectively to the several parts of the membranous labyrinth, namely, to the utricle, saccule, cochlear membrane, and semicircular canals.

OUTLINE OF THE DISTRIBUTION OF THE TRIGEMINAL NERVE.*

The fifth or trigeminal nerve arises *apparently*, as heretofore stated, from the lateral part of the Varolian bridge, where it presents itself in the form of two unequal-sized bundles or roots, which are totally distinct, although they proceed forward side by side to the upper surface of the petrous bone. Here the larger or sensory root spreads out to enter the ganglion of Gassa, beneath which the small or motor root continues on in the direction of the oval opening of the sphenoid bone.

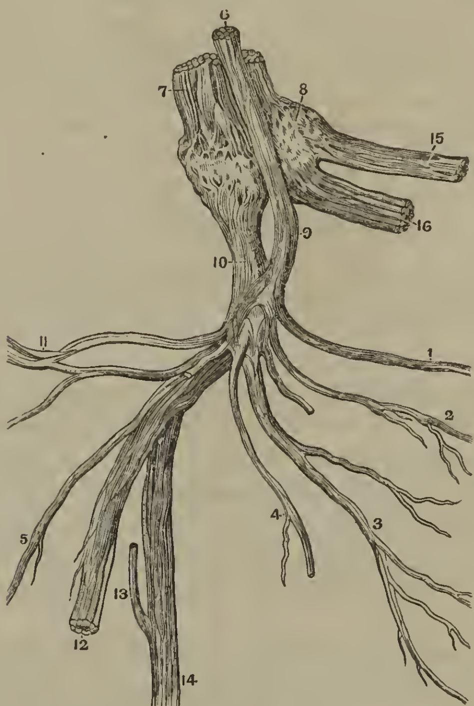
The *Gasserian ganglion*, the largest nervous ganglion in the body, except the semilunar, is situated upon the upper surface of the extremity of the petrous portion of the temporal bone and beneath the dura mater, which, on account of its close attachment, requires to be dissected off with great care. It is flattened from above downward, somewhat semilunar in shape, of a grayish color, and communicates upon its inner side with filaments from the carotid plexus of the sympathetic nerve. From its anterior or convex border three large branches are given off, namely, the *ophthalmic*, the *superior maxillary*, and the *inferior maxillary*.

The OPHTHALMIC NERVE, the smallest of the primary divisions of

* As it was not possible, in carrying out the original plan of this work, to give a connected account of the complicate arrangement of the fifth nerve, in connection with the description of the parts to which it is distributed, its introduction here became a matter of necessity.

the fifth nerve, passes forward along the outer wall of the cavernous sinus, where it receives filaments from the sympathetic, and sometimes a single one from the fourth nerve, enters the cavity of the orbit through the upper part of the sphenoidal fissure, and divides into three main branches, namely, the *lachrymal*, *frontal*, and *nasal*. Of

Fig. 267.

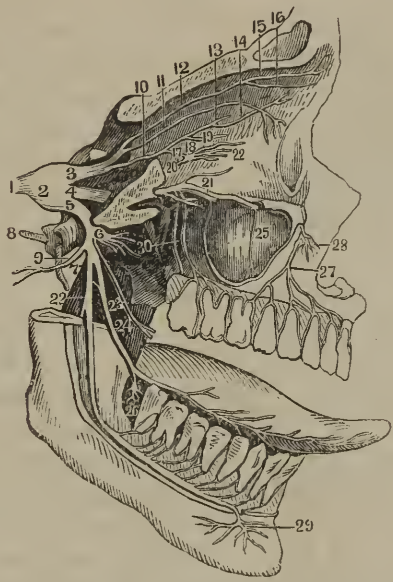


In order farther to illustrate several parts of this interesting nerve, it is here represented dissected out and seen on its lower surface. 7. Its posterior or sensitive root before it enters the ganglion. 8. Gasserian ganglion. 6. The anterior or motor root passing the gauglion. 10. The third or lower maxillary division. 9. The motor portion joining the lower maxillary nerve, and forming a plexus with it; from this plexus the muscular nerves are given off to the muscles of the lower jaw, thus: 1. Temporal. 2. Masseteric. 3. Buccinator. 4. Pterygoid. 5. Mylo-hyoid. The other branches are the following: 11. Division that joins the portio dura. 12. Inferior dental. 13. Chorda tympani. 14. Gustatory nerve. 15. First or ophthalmic branch of the fifth pair. 16. Second or superior maxillary branch.

these, the first is distributed to the lachrymal gland, conjunctiva, and upper eyelid; the second, the continuation of the main trunk, passes along the upper wall of the orbit, about midway upon which it divides into two or more branches; these continuing forward, emerge at the upper edge of the base of the orbit, the largest occupying the supra-orbital notch, and supply the skin of the forehead and upper eye-

lid; the third, the nasal branch, comes off from the main trunk while yet within the wall of the cavernous sinus, enters the orbit through the sphenoidal fissure, and passes forward and inward along the superior wall, to the anterior internal orbital foramen, through which

Fig. 268.



The annexed engraving, Fig. 268, illustrates the course and distribution of the three branches of the trigeminal nerve. 1. Trunk of the trigeminal. 2. Ganglion of Gasser. 3. First or ophthalmic branch. 4. Second or superior maxillary branch. 5. Third or inferior maxillary branch. 6. Muscular division of the latter nerve. 7, 8. Chorda tympani, showing its connection with the gustatory nerve. 9. The temporal nerve. 10. The nasal nerve. 11. The lachrymal nerve. 12. Frontal nerve. 13. Continuation of the nasal through the anterior ethmoidal foramen, into the nose. 14. Infra-trochlear branch of the nasal nerve. 15. Supra-orbitar branch of the frontal nerve. 15. Supra-trochlear branch of the frontal nerve. 17. Branch of the nasal nerve to the ophthalmic ganglion. 18. Ophthalmic ganglion (directly beneath the fissure). 19. Ciliary branch of the nasal nerve, going to the ball of the eye. 20. Branch given off from the ophthalmic ganglion to the inferior division of the third nerve. 21. Continuation of the superior maxillary nerve along the floor of the orbit. 22. Inferior dental nerve. 23. One of the muscular branches of the inferior maxillary nerve. 24. Gustatory branch of that nerve, going to the tongue. 25. Dental branch of the superior maxillary while in its canal, and passing between the mucous membrane and outer wall of the antrum to the teeth. The other dental nerves are seen behind it. 26. The submaxillary ganglion. 27. Anterior dental branches of the upper maxillary; exit of the infra-orbitar nerve. 29. Terminal branches of the upper maxillary, distributed to the face. The mental nerves, or termination of the inferior maxillary.

it re-enters the cavity of the cranium; it then crosses the cerebral surface of the cribriform plate of the ethmoid bone, traverses a small foramen by the side of the ethmoid crest, and is distributed to the lining membrane of the nose, one or more filaments reaching as far as the skin in the neighborhood of the nostril. While within the orbit,

the nasal branch furnishes an offset to the lenticular ganglion, several to the eyeball, called the ciliary nerves, and one, which continues forward, is distributed partly to the lachrymal sac and caruncle, and, emerging from the orbit, is expended upon the skin of the eyelid and side of the nose.

The SUPERIOR MAXILLARY NERVE, the second division of the fifth pair, arises from the middle of the anterior border of the Gasserian ganglion, passes horizontally forward through the round opening (*foramen rotundum*) of the sphenoid bone, crosses the spheno-maxillary fossa to reach the groove upon the back part of the floor of the orbit, traverses the infra-orbital canal, and, emerging at the infra-orbital foramen upon the anterior surface of the superior maxillary bone, divides into a lash of filaments which are distributed to the skin of the eyelid, cheek, and upper lip.

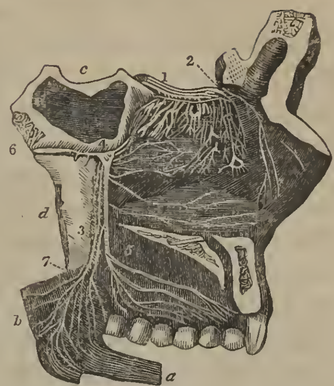
Before entering the infra-orbital canal, the superior maxillary nerve gives off the orbital, spheno-palatine, and posterior dental branches. 1. The *orbital branch* enters the orbit through the spheno-maxillary fissure, and divides into a temporal and a malar branch; the former proceeds forward along the outer wall of the orbit, near the anterior margin of which it enters a foramen in the malar bone, and is distributed to the skin of the temple; the latter runs to the lower outer margin of the orbit, also traverses a foramen in the malar bone, and is distributed to the skin of the cheek. 2. The *spheno-palatine* branches, two in number, descend to join the spheno-palatine, or Meckel's ganglion—presently to be mentioned. 3. The *posterior dental branches*, two in number, descend upon the tuberosity of the upper maxillary bone, which they perforate, and are distributed to the three molar teeth of the upper jaw and the contiguous gums.

While in the infra-orbital canal, the superior maxillary nerve sends off the *anterior dental branch*, which descends along a small groove or canal on the posterior surface of the anterior wall of the antrum, and divides into several branches which supply the canine and incisor teeth. The terminal branches of the superior maxillary nerve are large and numerous; they diverge from the infra-orbital foramen, and are distributed to the skin of the lower eyelid, side of the nose, and upper lip.

The SPHENO-PALATINE, OR MECKEL'S GANGLION (Fig. 267, 4), is an enlargement upon the spheno-palatine branches of the upper maxillary

nerve, situated immediately in front of the root of the pterygoid process of the sphenoid bone and near the spheno-palatine foramen. It is quite small, triangular, and of a gray color, and gives off numerous branches, which descend and are distributed to the mucous membrane of the hard and soft palate, uvula, gums, tonsils, and lining membrane of the nose, as represented in the annexed figure.

Fig. 269.



A view of the olfactory nerve, and of Meckel's ganglion seen from the inner side. (From Scarpa.) *a.* Elevator muscle of the soft palate thrown down. *b.* Part of the soft palate. *c.* Body of the sphenoid bone. *d.* Internal pterygoid plate. 1. Bulb of the olfactory nerve, giving branches over the upper two spongy bones. 2. Nasal branch of the ophthalmic nerve. 3. Smaller palatine nerve. 4. Meckel's ganglion. 5. Larger palatine nerve, dividing in the roof of the mouth. 6. Vidian nerve. 7. External palatine nerve.

The *Vidian nerve*, considered as an offset from this ganglion, leaves its back part, passes through the Vidian or pterygoid canal, and divides into two principal branches. One of these divisions, called the *superficial petrosal nerve*, enters the cranium through the sphenoidal fissure, passes along the outer side of the internal carotid artery and beneath the Gasserian ganglion, and enters the groove leading to the hiatus Fallopii, through which it reaches the ganglion of the facial nerve. The other branch, called the *carotid*, joins the sympathetic nerve upon the surface of the carotid artery. Besides these, the Vidian also sends filaments to the lining membrane of the back part of the roof of the nose, the nasal septum, and Eustachian tube.

The INFERIOR MAXILLARY NERVE, the third and largest division of the fifth, unlike the two others, consists of both a motor and sensory trunk, the former being the continuation of the motor root heretofore mentioned, and the latter one of the offsets from the ganglion of Gassa. The two portions enter the oval foramen of the sphenoid bone, and then unite to form a common trunk, which, a short distance below the base of the skull, divides into two main branches known as the superior or small, and the inferior or large division, of which the former contains most of the motor fibres. The superior division furnishes the following branches: 1. *Deep temporal branches*, two in number, distributed to the temporal muscle; 2, the *masseteric branch;* 3, the *buccal branch;* and 4, the

two *pterygoid branches*, distributed respectively to the masseter, buccinator, and two pterygoid muscles. The inferior or larger division subdivides into the auriculo-temporal, gustatory, and inferior dental nerves. The *auriculo-temporal* turns backward from the main trunk beneath the external pterygoid muscle and upon the inner side of the articulation of the lower jaw, then ascends beneath the parotid gland in front of the ear, and gives branches to the ear, temporal muscle, anterior muscle of the ear, and skin of the side of the head. The *gustatory nerve*, the special nerve of taste, is directed downward and forward beneath the external pterygoid muscle, and between the internal pterygoid and lower jaw to the side of the tongue, along which it is continued just beneath the mucous membrane to the apex, sending numerous delicate filaments to the papillæ of the organ, the submaxillary ganglion, gums, and sublingual gland. The *inferior dental nerve* descends from its origin in company with the gustatory, which it soon leaves, however, to enter the dental canal upon the inner face of the ramus of the lower jaw, having previously given off a small branch to the mylo-hyoid muscle. Within the canal it passes forward, in company with the dental artery, as far as the symphysis, sending filaments to each tooth, and a large branch through the dental foramen to the skin of the lower lip and chin.

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THE END.

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